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THE PACIFIC CABLE.

ON the day preceding the large meeting held in the Cannon Street Hotel, to pass certain resolutions in connection with drawing the attention of Government to the unsatisfactory state of the telegraphic communication with our Australasian Colonies, the Eastern Extension Telegraph Company wishing, naturally, to safeguard its own interests, thought fit to send a letter to the City Editor of the *Times*. Besides being a weak defence, this letter has lent itself to certain statements not only "exaggerated and misleading," but actually contrary to fact. In the letter of the 21st ult., the Secretary commences by complaining that the circular sent out by the Pacific Telegraph Company is "misleading and exaggerated." Surely this assumed honesty should have prevented him from falling into the same error, and should have made him more careful in the choice of the statements which he himself makes. To begin with, the first communication with Australia was not established by the Eastern Extension Telegraph Company, but by the (?) British Australia, Australasia and China Telegraph Company? which was afterwards incorporated with the British Indian Extension Company to form the Eastern Extension Company. This is a small matter, and may be a slip on the part of the Secretary, who is well aware of the fact. Again, it may be designedly made, as the character and history of the former company is better buried in oblivion. The bungling cable-laying expedition, and the want of ability displayed, were notorious at the time that the cables were being laid as a disgrace to submarine telegraphy. Mr. Hesse, the Secretary of the Eastern Extension Company, has been made to say that the Australian Governments gave the subsidies at this period in order to secure duplicate communication, and so to provide against interruptions, *inseparable* from a single line of cable. The correct statement is that the Colonies, despairing of maintaining communication with a cable laid as the first cable had been laid, were wheedled and almost coerced into granting a subsidy for a new cable, as the only way, for them, out of the difficulty.

The value of the general statement of Mr. Hesse, as to the interruptions since the duplication, can be best appreciated by the Australian and New Zealand merchants and bankers, and when it is noticed that the principal among these were the convokers of the meeting in the Cannon Street Hotel on the 22nd ult., the public also will be able to appreciate the value of such generalisations. Mr. Hesse also says that the cables lie mostly in shallow water, and that they are duplicated, and in some cases triplicated. The first statement is partially true, if Mr. Hesse includes the China cables of the Eastern Extension Company; but what cables between Singapore and China have to do with the communication between India and Australia is difficult to understand. As to the second statement, we are not aware that any of the Eastern Extension Company's cables are triplicated, nor are we aware that the Madras-Penang cable of their system is even *duplicated*. Mr. Hesse evidently relies, to make this statement valid, on the Indian Government landline which connects Calcutta with Rangoon, at which town there is a landing of a cable from Penang. It would be interesting in this connection to know whether messages from Rangoon to Calcutta do not frequently pass through the single cable which connects Penang with Madras. If Rangoon traffic takes the submarine road, the small value of the Rangoon-Calcutta landline as a duplication stands self-evident.

Mr. Hesse says that because most of the cables lie in shallow water they are easily repairable; this is true, but it is also true that they are easily interruptable, and for the same reason. The statement that the existing telegraph system between England and Australia is under English control is simply not true; Egypt and Java intervene. The technical argument employed to explain one of the interruptions of the Java-Australia cable is simply ridiculous. It is said that the repairing ship interrupted one cable while employed in repairing the other, because the *strong currents off Java drifted the cables together*. From this it is evident that we are asked to believe that there were two currents, one for each cable, flowing in contrary directions, in the same place and at the same time, so that each cable was carried by its own current towards the other, which was coming to meet it. Is this a serious statement, or is it a joke at the reader's expense? It is well known that the depth of water in which the accidents he referred to occurred is too great for the surface currents near Java to have any great influence on the cable lying at the bottom. The true reason seems more probably to have been the careless pitching overboard of the cable during laying, or the want of knowledge and ability on the part of the navigating officers of the cable ships employed. If the existing cables have throughout their length been laid in this fashion, what else can we expect but constant interruptions?

The laying of a third cable from Java to Australia is no doubt an extra security for the communication, and it is to be hoped it will be laid with the care and the ability which this work should demand, but experience does not justify much confidence in that the work will be properly done. In Mr. Hesse's letter he appeals to the public to "pity the poor pioneer," and yet he does not care to apply this pity in advance to the would-be Pacific pioneer. Strange argument! He tries to convince the subvention-paying public that the new line will never work because of technical difficulties, of which, to judge by such demonstration as his letter gives us, he is no great authority. He uses arguments which were used against Mr. Cyrus Field and his chairman, Sir John Pender, when these gentlemen, in common with many others, were trying to establish

transatlantic communication by telegraph. He says the Governments should give no subsidy because the Pacific line will be subject to interruption. If he is correct in principle why does his company receive a subsidy from the Colonial Governments; surely he cannot consider his cables free from interruption? Mr. Hesse seems to forget that a subsidy is generally given on the basis of no communication no subsidy. This being so, we fail to see where the Governments will be wronged should interruption occur. If he hopes to intimidate the persons willing to put money into the scheme he wastes both ink and paper. Why should the Eastern Extension Company object to another company receiving a subsidy on high moral grounds when this company itself is also a recipient of such aid. The reasons are very apparent, they are purely selfish as they should be in like case, but certainly the humbug of imputing high moral aims to his contention, a selfish one, is humbug in its very worst form.

Mr. Hesse's remarks conclude in assuming that the laying of two cables is unavoidable, and to value the capital amount necessary for carrying out the Pacific cable scheme he uses this as a basis and applies a cost per mile which he has probably extracted from the inflated cost of his own cables as this cost appears in the books of the Eastern Extension Telegraph Company. As to the proposal in his last paragraph, does he think that John Bull, however stupid he may be, is prepared to give him, say a 6 Per Cent Imperial Parliament Guarantee on a capital represented by cables probably averaging an age of six years, and priced at a figure double that for which these cables could be replaced by new ones? Governments do things which are sometimes peculiar, but this proposal of the Eastern Extension Telegraph Company seems too transparent.

THERE are always numerous individuals who are ready to maintain that railway travelling will eventually reach a speed of 200 miles an hour, and that the medium by which this never-to-be-attained pace will be reached is electricity. Enthusiasts of this type might read with advantage an excellent leading article on "Train Resistance" which appeared in the *Engineer* for November 16th, which would, we believe, effectually convert them to more sane views on the subject.

WE have recently seen in the correspondence columns of an influential newspaper a proposal for the taxation of quacks. This, at first sight, might seem to be a capital idea, and, if carried out, one which would ensure that those who prey upon the credulity of the ignorant public (and it is surprising what an enormous proportion of the "public" *is* ignorant), should contribute substantially to the national exchequer, and thus indirectly aid those whom they first rob. But the difficulty is, that such a proceeding would legalise and strengthen the position of the quack, would give him standing as, in a shape, a licensee of the State, and he might be depended upon to make known in the most plausible way that he and his appliances were countenanced by the powers that be. This would most assuredly have the effect of inducing additional confidence in the quack's skill and ability to do what he promised, and thus the remedy would be worse than the ill. No; the only way that seems open to scotch, if we cannot actually kill, this particularly objectionable reptile, is to continue the exposure of him and all his works through the medium of respectable journals.

HERE we pause to enquire which are the respectable journals? We have seen it stated that the leading London newspapers habitually refuse to insert the advertisements of quacks. They may imagine they do so; but they are mistaken. No matter how generally exclusive, or how select, the columns of a newspaper, the greatest quack of them all seems to possess the "open sesame," and holds forth with unblushing effrontery in plausible paragraphs, which are made to read as nearly like editorials as it is possible to make them without destroying their usefulness as advertisements. We regret that this is so, and once more appeal to the great journals which circulate amongst all classes, and which have a wider influence than a technical paper can possibly obtain, to bethink them of their plain duty in this matter. Seeing these advertisements in a reputable newspaper, the unsophisticated reader at once imagines that he may safely respond to the blandishments of the man who promises him a speedy cure from whatever disease may happen to be his. The example of the great lights in the journalistic firmament, too, exercises an evil effect upon the smaller satellites. They reproduce and quote; they accept corresponding advertisements, and they seem anxious to disseminate the renown of a great benefactor of the human race. If they but knew how this renown originated, and by whom the title of the benefactor, as well as some other more formal titles, were bestowed, would they still accept the money of the charlatan and pretender, and continue to blazon forth his false reputation?

WE particularly regret to see a quack electro-medical appliance advertisement in the pages of the *Palace Journal*, the organ of the Peoples' Palace. Are the managers of this excellent institution aware of the real character of this particular advertiser? If not, we would beg them to look through a few back numbers of the REVIEW. Doubtless there are those engaged on the teaching staff of the Palace who are able to enlighten the editor of the *Palace Journal* upon this matter, and we trust they will at once proceed to do so. We are sure that Mr. Walter Besant, whom we believe to be as great a lover of the genuine and true as any man, would be grieved to the soul if he knew that he was assisting unworthy efforts to take from poor people without giving them adequate return; and we believe that the popular novelist is in some way identified with the *Journal* of the Palace which he has worked so nobly to establish.

IT would almost seem that the experience of many years in practical telegraphy goes for "nowt" when electric lighting is considered, for what other construction can be placed upon the remarks made by Mr. W. H. Preece at the meeting of the Society of T.-E. and E. the other evening when speaking on Mr. Edmunds's paper, "A System of Electrical Distribution." He remarked (see our last issue): "I have only recently heard that somebody has planted his foot

down upon pure India-rubber. Well now, it is rather a curious thing that we in the Post Office who have had some experience in the use of insulating materials of different kinds will specify pure India-rubber only for our aerial cables that have to carry currents, whereas, we are now told that pure India-rubber is entirely tabooed, it must not be used, and that nothing but vulcanised India-rubber must be employed. That may be all very right, it may be very true and very just, but at the same time we practical men who have had 30 years' or more experience of pure India-rubber would like to know why that substance that we have used so much, now, in the year 1888 turns out to be bad." We ourselves should very much like Mr. Preece's question answered, and the reasons given for this material being considered bad and practically condemned for electric light installations. Our own experience in the matter thoroughly bears out Mr. Preece's statement, and we are satisfied that pure India-rubber is a material whose lasting qualities as an insulator are vastly superior to the cured rubber now patronised. Let facts speak for themselves. We have now before us two samples of wire insulated with pure rubber which were sent to us in the latter part of 1881, they were taken from wires which had been *in the ground*, not in pipes, for 25 years. At present, therefore, they are 32 years old, and since reading Mr. Preece's remarks we submitted these samples to an experienced manufacturer of India-rubber, who stated that they were of pure rubber and at the present moment quite fresh and good. There are plenty of similar instances to be obtained from practical telegraph men whose experience commenced with the first application of rubber to telegraphic purposes. This is, however, but one case among many which are occurring in the new industry. It may be assumed, therefore, that in electric lighting the usually accepted truism *Experientia docet* does not apply. General Taboo will have none of it. What would be thought amongst insurance companies if the principal messenger at T.S. revised the fire insurance rules!

WE believe that the Grosvenor Gallery installation greatly impresses visitors from abroad who are permitted to inspect the plant. As one gentleman expressed himself, it is really wonderful how so large a district is supplied with the electric light from machinery closely packed in a hole, and still more so that accidents are so rare with such a high voltage employed in a place which is not proof against the inroads of rain.

WE learn through the medium of a contemporary that the position of the transformer stations fed from the Deptford Central depôt are practically decided, and Cannon Street, Ludgate Hill, and Charing Cross are named. A fourth transformer station will be at the Grosvenor, and from this point to Charing Cross the main primary circuit will be overhead; this portion, indeed, having already been wired for 10,000 volts. No difficulty is anticipated with this high voltage, the cables having been specially manufactured by the India-Rubber and Gutta-Percha Company, of Silvertown. These cables are composed of 61 strands of copper wire of about No. 17 gauge doubly covered with extra thick rubber having a resistance of 60,000 megohms. This, we presume, is intended to represent the dielectric resistance per mile, although it is not so stated. We are also assured on the same authority that Mr. Ferranti's new type of conductor is not insulated with paraffined paper, an item of news which we are pleased to chronicle. It is possible that the leads of the Silvertown Company may yet be necessary to replace those of Mr. Ferranti, but as these are not yet erected we may perhaps be premature in this remark.

THE letter which we publish on the subject of the voting list of the Society of Telegraph-Engineers and Electricians will not, we think, excite any great degree of sympathy with the views put forth by the writer. It seems that the Society has drifted into the position which it now occupies purely through force of circumstances. Our correspondent seems to forget that in the days of the Society's birth there was then only telegraphy existing, and at the same time he is quite incorrect in asserting that "to-day, except amongst the shelved presidents, there is not a single name known to telegraphy." As a matter of fact, there are on the present council three members whose names are well-known and who are very closely identified with telegraphy, and there is certainly one proposed new member on the list of recommendations whose name and telegraphy are synonymous terms. Why does not "Telegraphy" and some of his friends contribute telegraphic papers to the Society instead of practically standing aloof and then grumbling? With regard to the change in the Society's title, surely our correspondent must be aware that nearly 1,000 members voted in favour of the alteration with about nine dissentients only? Ten years ago the Society was in reality a telegraphic body, but we have changed all that now. Nevertheless there is much reorganisation necessary before the Society becomes tasteful to the various sections of the Electrical industry, and some of the remarks to which "Telegraphy" has given vent may perhaps find an echo in the hearts of others.

THE letter of Mr. Richardson, which we publish this week, brings to our recollection the fact that the much respected London Editor of *Industries*, Mr. Gisbert Kapp, made some experiments when associated some years ago with Messrs. Crompton, on the effect of the magnetic field upon the human frame. Mr. Kapp, we believe, withdrew the armature of a dynamo and inserted his head in the space between the pole pieces, the field being powerfully excited from an external source. The result of this reckless action we do not know, but probably Mr. Kapp's good nature will prompt him, if his numerous engagements will enable him to devote a little time to the subject, to come to the aid of our correspondent with the undeniable authority of personal experience.

THE paper which we publish by Mr. Legh. S. Powell seems to open up a new field for the application of electrical energy. The idea of lighting fires electrically is, however, not new, a note on the subject having appeared some years ago in the REVIEW, the inventor of the system being, if our memory serves us aright, a lady professional athlete. The utilisation of a general electrical supply for the purpose, however, did not of course enter into the circumstance to which we allude, which was purely a domestic expedient of lighting the kitchen fire by pressing a button in the lady's bedroom.

INAUGURATION OF THE STATUE OF AMPERE.

DISCOURSE DELIVERED BY M. CORNU.

WE find in the history of science names whose lustre goes on increasing with years in proportion as succeeding generations appreciate more fully the grandeur and the fecundity of the work to which such names are attached. Such is the name of André Marie Ampère.

Born at Lyon on January 22nd, 1775, your illustrious fellow citizen early showed a wonderful intelligence joined to a prodigious memory; he learned everything spontaneously.

His father whose doom it had been to perish as a victim of the blood-thirsty passions of the day, had been a witness of his thirst for study which he sought to satisfy. "As for my son (he wrote the evening before his death) there is nothing which I do not expect from him."

The future justified this paternal forecast. Young Ampère first turned his intelligence to transcendental mathematics. His first work, "Considerations on the mathematical theory of gaming," which contains the solution of a difficult problem of the calculus of probabilities, bears the mark of a vigorous and profound spirit. He wrote it in the midst of the most painful preoccupations at Bourg, at the Central School of the Department of L'Ain where he was professor of physics and chemistry in 1802 and 1803.

This first work attracted the attention of Delambre, who along with Villar was commissioned to recruit the teaching staff of the Lyceums then in course of creation. A second work, "The application of the calculus of variations to mechanics," earned for him the patronage of Delambre, and enabled him to leave the unpleasant position which he occupied at Bourg. He was nominated Professor of Mathematics at the Lyceum of Lyon.

He was thus enabled to return to his young son, Jean Jacques Ampère, who became subsequently an eminent academician, and to his wife, whose health declined daily.

On her death, residence at Lyon became insupportable to him. Fortunately his patrons, Lalande, Delambre, and Laplace, called him to Paris as "repititeur" of analysis at the "Ecole Polytechnique." There, sharing his time between the philosophers and the mathematicians, he again took pleasure in his studies, and soon won the esteem of the learned world by the profundity of his views and the variety of his conceptions.

In 1808 he was nominated Inspector-General of the University, and in 1809 Professor of the Courses of Analysis and of Mechanics at the Ecole Polytechnique. Lastly, in 1814, he was elected a member of the Academy of Sciences in the mathematical section.

Fresh memoirs concerning the most elevated questions of mathematics raised him to the highest rank in that science. But these researches were merely the prelude to more important discoveries. From being a great mathematician he became a still greater physicist, and it is in this character that he will be most honoured by posterity.

In the beginning of September, 1820, the Academy of Sciences heard of the discovery of Oersted, that the wire connecting the poles of a galvanic battery acted upon the magnetic needle.

A few days later Ampère completed this great discovery by giving precision to all the conditions of the experiment. He was the first who defined the electric current, giving it a direction and summing up the phenomena in the celebrated rule that "the south pole is deflected to the left hand of the current.

He detected in the movements of Oersted's needle the solution of a great problem, which had for more than a century hovered before the physicists of all countries. These movements of the needle are signals which may represent letters, and the connecting wire, if prolonged, must transmit them immediately to any distance. Electric telegraphy, in principle, was thus invented.

Ampère afterwards applied all the power of his mind to the study of electro-magnetism. At every meeting of the academy he brought forward new discoveries. Step by step he announced the reciprocity of the action of magnets upon currents, the direction of a movable current by terrestrial magnetism, the reciprocal action of currents, creating thus a new branch of science, *electro-dynamics*, and finally identifying currents and magnets.

Thus, in a few weeks, there was effected a true revolution in physics. Magnetism, which had formerly been separated from electricity, ceased to be a distinct agent. The magnetic properties, regarded as peculiar attributes of iron and steel, became a general phenomenon, common to conductors of all kinds. Ampère discovered at the same time the proper form to be given to conductors to reproduce most exactly the properties of magnets; this is the electro-dynamic cylinder, or solenoid, which is made by folding a metallic wire into a helix, traversed by a current. The helix presents at its two extremities opposite poles. If suspended freely, it shows the north like a compass, and so long as it is traversed by the current, nothing distinguishes it from a real magnet.

There only remained one step to be made to arrive at that discovery, which involves the most extraordinary consequences in science and industry.

This step was taken by Ampère and Arago in the memorable experiment where the two illustrious friends had the idea of introducing a bar of soft iron into the electro-dynamic coil. The electro-magnet was invented.

When Arago, wishing to express his admiration for the work of his friend, exclaimed before the Academy of Sciences: "We say the laws of Kepler, and we shall say the laws of Ampère," he foresaw the judgment of posterity,

But the supreme testimony of admiration comes to him from abroad, from the country of Davy and Faraday. Maxwell, an illustrious English savant, ventured to say: "Ampère is the Newton of electricity."

The name of our great physicist merits in very way to become popular. It became so, in fact, on the day when, by a delicate homage to the memory of the great men who have most contributed to the progress of electrical science, Volta, Ohm, Ampère, Faraday, Coulomb, the electricians of all countries, assembled in congress, decided that these names should serve to designate the various units. Since that day, in the entire world, the name of Ampère, a synonym for the unit of current, is pronounced by thousands of lips in the laboratories of savants, as well as in the most modest workshops.—*La Lumière Electrique.*

A 10,000 VOLT TRANSFORMER.

THE usual tests of insulation consisting only of a measurement of the insulation resistance afford very little guarantee, especially in the case of electric light cables, for the working strength of the insulation, seeing that the test is usually made by means of laboratory batteries having a comparatively low E.M.F.

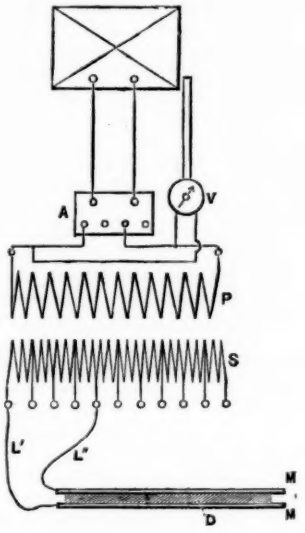
At the "Menier" electric cable works in Paris-Grenelle an alternating current transformer, made by Messrs. Ganz & Co., of Budapest, has been used since March, 1888, for the purpose of testing cable insulation as well as any dielectric. This transformer is constructed with a primary coil, P, for 100 volts and 70 ampères, and a secondary, S, for 10,000 volts and 0·07 ampéres, the ratio of transformation being 1 : 100.

The secondary coil is divided into 10 divisions, the ends of which are led to metal contact pieces with conical holes. By means of two plugs and two flexible leads, L′, L″, the dielectric to be tested can be subjected to a difference of potential of from 1,000 up to 10,000 volts, and its behaviour observed.

In the primary circuit there is, as well as the gene-

rator, a double pole switch, A, in order to cut off the primary circuit entirely before altering the secondary difference of potential by shifting plugs. A Cardew voltmeter indicates for the control of the primary potential.

Concerning the construction of the transformer, it may be mentioned that the primary and secondary coils, as well as the divisions of the secondary, are carefully insulated from one another with ebonite. The metal pieces forming the terminals of the secondary divisions are mounted on high ebonite supports, the metal plugs being also furnished with long handles of the same material.



The transformer, together with the terminals, are mounted on a strong base board, on which there is also a double pole switch with porcelain base and handle.

This method of testing the insulation of cables affords a far better guarantee for their safe working in actual use than that of testing by measuring the insulation resistance with a comparatively low E.M.F.

THE GRAMOPHONE.

THE Berliner gramophone is an apparatus for making permanent records of the human voice or other sounds, or music of any kind, and for reproducing the same at any time thereafter, and as often as desired.

It differs from other apparatus for the same purpose in some very important points :—

1. It reproduces the sound so loudly, that several hundred, or even a thousand persons can hear them at the same time.
2. It reproduces the voice with absolute fidelity, so that even without previous knowledge a voice is recognised by those familiar with the same.
3. The sounds records are grooves of even depth, but of varying direction.
4. The records are in metal, or other indestructible material.
5. The records can be multiplied, and each copy will sound exactly like the original one.
6. The reproducing machine has no gear or other intricate mechanism, save a turn-table moved by a friction wheel and by hand or motor.
7. Voices can be analysed by studying the beautiful record lines which they show in the phonautograms.

History.

The gramophone bears no resemblance, in a scientific aspect, to the phonograph or the graphophone. It is based on the Leon Scott phonautograph, which was invented over 30 years ago, and which traced sound as curvilinear lines upon a smoked surface. In April, 1877, or six months before the discovery of the phonograph principle, Mr. Chas. Cros conceived and placed on file the idea that if the curvilinear record of a Scott phonautograph be photoengraved, and such an engraving be made to act on a stylus attached to a diaphragm, the original sound would be reproduced.

This was the first conception of a sound reproducing machine ; Mr. Cros, however, did not put his idea into operation, probably on account of the many mechanical difficulties which have to be overcome in order to accomplish it.

A few years ago, and without having had any knowledge of Mr. Cros, Mr. Berliner set out on a similar principle to reproduce the human voice, and after much study and experimenting, secured patents for the general process and for important details in the United States and Europe.

In his machine, which he called the gramophone (from phonautogram or phonautographic record), the voice is first traced as curvilinear lines on a metal plate covered with a very delicate layer of a fatty etching ground, and the lines are then etched into the metal plate by immersing the same in acid for from 10 to 30 minutes. From this etched record the voice can then immediately be produced and copied by electrotyping, or other modes of multiplying.

Practical Applications.

In a paper read by Mr. Berliner, he spoke as follows by invitation before the Franklin Institute of Philadelphia, May 16th, 1888, concerning the practical applications on the gramophone :—

A standard reproducing apparatus, simple in construction and easily manipulated, will at a moderate selling price be placed on the market.

Those having one may then buy an assortment of phonautograms, to be increased occasionally, comprising recitations, songs, and instrumental solos or orchestral pieces of every variety.

In each city there will be at least one office having a gramophone recorder with all the necessary outfits. There will be an acoustic cabinet, or acousticon, a very large funnel, or other sound concentractor, the narrow end of which ends in a tube leading to the recording diaphragm. At the wide opening of the funnel will be placed a piano, and back of it a semi-circular wall for reflecting the sound into the funnel. Persons desirous of having their voice "taken" will step before the funnel, and upon a given signal sing or speak, or they may perform upon an instrument. While they are waiting the plate will be developed, and, when it is satisfactory, it is turned over to the electrotyper or to the moulder in charge, who will make as many copies as desired.

The electrotype shells are mounted on thick pasteboard, and this is backed by a stiff piece of metal. There is another process which may be employed. Supposing that the Holy Father should desire to send broadcast a pontifical blessing to his millions of believers, he may speak into the recorder, and the plate then, after the words are etched, is turned over to a plate printer, who may within a few hours print thousands of phonautograms on translucent tracing paper. These printed phonautograms are then sent to the principal cities in the world, and, upon arrival, they are photoengraved by simply using them as photograph positives. The resultant engraved plate is then copied, *ad infinitum*, by electrotyping or molding, and sold to those having standard reproducers.

Prominent singers, speakers, or performers may derive an income from royalties on the sale of their phonautograms, and valuable plates may be printed and registered to protect against unauthorised publication.

Collection of phonautograms may become very valuable, and whole evenings will be spent at home going through a long list of interesting performances. Who will deny the beneficial influence which civilisation

will experience when the voices of dear relatives and friends long departed, the utterances of the great men and women who lived centuries before, the radiant songs of Patti, Campanini, and others, the dramatic voices of Booth, Irving, and Bernhardt, and the humour of Whitcomb Riley, can be heard and reheard in every well furnished parlour?

Future generations will be able to condense within the space of 20 minutes a tone picture of a single lifetime—five minutes of a child's prattle, five of the boy's exultations, five of the man's reflections, and five of the feeble utterances from the deathbed. Will it not be like holding communion even with immortality?

From this it can be seen that the gramophone is intended and expected to be for the voice what photography is for the features—*i.e.*, secure a lasting record of voices. Every detail of the apparatus is now so far perfected that as soon as machines can be made an immediate market can be found for them.

The gramophone stands independent of other patents, and the historical records show that its fundamental principles are the oldest conceptions for the preservation of sound.

REPORT ON THE EXAMINATION OF LIGHTNING CONDUCTORS.

By GUSTAV FRISCH, of the Electrotechnical Institute of the Imperial and Royal Technical High School at Vienna.

THE objects of investigation, according to the commission received, were the lightning conductors of the Theatre and the Municipal Archives of the city of Oldenburg, in Hungary.

The conductor of the theatre has three rods, terminating in points, and each of four metres in height. The height, number and the arrangement of these rods is in accordance with the recommendations laid down by a committee of the Electrotechnical Association of Berlin, since the highest points of the building lie within circles whose radii are $1\frac{1}{2}$ times the heights of the rods.

The above-ground conductor passes down both fronts of the building into the earth, leading on the one side to a plate of 1 square metre sunk to the bottom of a neighbouring well, and on the other side to a second plate of $\frac{1}{2}$ square metre, which is laid in the moist earth beneath the sewer.

This conductor consists of a rope of copper wire made up of seven strands, each $2\frac{1}{2}$ millimetres in thickness. It has consequently a metallic section of 34·3 square millimetres, and as there are two such conductors there is a section of 68·6 square millimetres of copper available for the passage of electricity. The conductor is therefore, as regards its dimensions, within the prescribed size of 65—70 square millimetres.

The conductor on the approach side of the theatre passes into the ground by a rain channel, which has the disadvantage that an ocular examination of this part of the conductor is rendered impossible. Such an ocular examination of the continuity of the conductor, the integrity of the soldered joints, and the points of the receiving rods has been carried out annually by the officials of the city architect, and hitherto no defects have appeared.

The so-called "galvanometric" method was here first applied, and gave a satisfactory result. It was, however, regarded merely as a preliminary test, since it is only capable of detecting very gross defects.

A determination of the electric resistance of the above-ground conductor lead was not undertaken, because it cannot give the desired result, even if carried out with very accurate instruments. In the first place, the resistance of the conducting wires is much greater than the slight resistance of the rope of copper wire, and the latter, as Kohlrausch has shown, undergoes such trifling modifications, even in the case of considerable defects, that they cannot be detected by measuring the resistance. A thorough ocular examination is here decidedly preferable.

The conductor is in efficient connection with the metal roof, though certain sharp turns should have been avoided. If a conductor in obtuse curves would now no longer be possible, there is nothing left but to provide all curves with exit points.

In order to judge of a system of lightning conductors it is particularly important to examine the ground conductor as to its resistance and the connection with any large masses of metal which may be present.

The resistance of the ground conductor was determined with the Kohlrausch telephone bridge, which, along with other necessary appliances, was courteously placed at my disposal by the director of the Electrotechnical Institute of the Imperial and Royal Technical School of Vienna, Prof. A. von Waltenhofen. By means of this instrument the polarisation of the earth plates is eliminated as far as possible, in consequence of the alternating currents employed.

As there is near the building a second well, at about 11 metres distance from the well above-mentioned, containing one of the earth-plates, the measurement was begun by applying one of the two conducting wires of the measuring bridge to the suction pipe of this second well, and the other to the aërial portion of the lightning conductor, when the resistance observed was determined. Repeated measurements gave a value of 25 ohms.

This resistance is composed of the earth resistance of the two plates—the value to be determined—increased by that of the auxiliary earth conductor in the second well. As the latter had a smaller surface, it could be admitted that the resistance sought for must be *smaller than half the value, 25 ohms, as found on observation.* In fact, on further measurements, in which the gas main in the street (not connected with the lightning conductor) was used as an auxiliary earth conductor, there was found a resistance of 11 ohms, which may be regarded as the diffusive earth resistance of the lightning conductor, as that of the gas main is very trifling.

If, in accordance with Neeson and Weinhold, we assume the maximum permissible earth resistance as 20 ohms, this result may be regarded as satisfactory, since by connecting the conductor with the gas mains, this resistance would be extremely diminished. Hence a more accurate measurement, according to the methods of Schwendler and Ayrton, Nippold, or Froelich, as originally intended, was not considered necessary.

The connection of gas and water mains to the conductor has latterly been made the subject of manifold investigations, and since such scientific bodies as the academies of Paris and Berlin, and the above-mentioned sub-committee of the Berlin Electro-technical Association, and in addition eminent specialists, such as Kohlrausch, Töpler, Uppenborn, Von Waltenhofen, Weinhold, &c., have pronounced in favour of the necessity of such a connection, this question may be regarded as decided.

It must now be remarked that the lightning conductor of the theatre was not in any way connected with the gas or water mains.

I therefore made the following suggestions:—

The highest part of the system of gas pipes, *i.e.*, the pipe supplying the large gaselier, should be connected by a rope of copper wire of 65—70 square millimetres section to the conductor running along the ridge of the roof. In the same manner a connection is required at the part where the gas main enters the building. Such another rope of copper wire should be carried over the gas regulator and the meter, and a similar rope must be provisionally introduced whenever any portion of the gas system is removed for the purpose of repairs. This precaution applies not merely to gas piping within the building, but to any mains in the street near the theatre.

The iron curtain should also be connected with the conductor on the one hand at the metallic bearings of the iron roller in the top loft, over which is passed the rope of iron wire supporting the curtain, and on the

other hand, at the bottom of the iron rails which guide the curtain.

The lightning conductor of the City Archives has two receiving rods, terminating in points, each 4 metres in height placed at the front of the building. From these passes a rope of copper wire, consisting of nine strands, each of 2 millimetres in diameter, having consequently a metal section of 28·3 square millimetres and leading to a plate of 1 square metre surface.

The above ground conductor was found to be in order. The resistance of the earth conductor measured by using the gas main as an auxiliary conductor (though it does not lead into the building, which is not supplied either with gas or water) amounts to 17 ohms.

This installation must be pronounced inadequate in several respects.

Firstly, the receiving rods are both at the front of the roof, whilst the back and the ends are unprotected. The conduction to the earth is far too feeble, and the earth resistance borders closely upon the limit considered as inadmissible.

I recommended the following alterations :—

The erection of at least two further receiving rods, one at the side and one at the back of the roof. The conductor on the ridge is to be continued to these rods, and from thence a second conductor of at least 37 square millimetres section is to be carried down to a second earth plate of 1 square metre. This plate may be placed in the moist earth below the sewer in the court.

The reason why the authorities desired this investigation was that a private house, fitted with a conductor had been recently struck by lightning, and a person in a bath had been injured.

I had no authority to undertake measurements in that house, or to examine the conductor. But I ascertained the following facts :—

In the upper story of the house is a large iron cistern from which pipes pass down to the bath room in the lower stories. This reservoir was *not* connected with the conductor, and it was officially ascertained that the lightning struck over from the conductor to the reservoir. The pipe leading down from the reservoir does not lead to earth, but ends in a bath room on the ground floor where it is closed by a cock. We can, therefore, understand that a person in the bath might be injured, since it had been omitted to connect the end of the water pipe with the waste pipe leading to the sewer. It is possible that the earth conductor had too high a resistance, but this case proves the necessity of connecting lightning conductors to the gas and water mains.—*Zeitschrift für Elektrotechnik.*

ELECTRIC LIGHTING OF DOMESTIC FIRES.

By LEGH S. POWELL.

THE title of this article at once suggests a very obvious application of the electric current, but it is one which, notwithstanding its suggestiveness, the writer has never hitherto seen or heard mentioned. Electric furnaces are doubtless familiar to everyone but slightly acquainted with modern electrical matters, but these appliances are, of course, essentially different to the application at present under consideration.

Where a house is supplied with the electric current for the purpose of illumination, there is no reason why the fire grates should not be constructed so as to be easily lighted by the electric current, and many grates in ordinary use would require but little alteration to render them suitable for the purpose. As cinders and coke are conductors of electricity, all that is requisite to produce incineration of the fire by electric means, is to make the bars one pole of the arrangement and a plate of iron, inlaid into the back fireclay part of the grate, the other electrode. On laying cinders or coke, of suitable size, between these terminals, and then switching on the current, the heat developed in the circuit occurs exactly where it is required, viz., at the points of contact between the pieces of fuel, these localities being those of the highest resistance.

It is thus evident that the principle of fire lighting by electric means is simple enough. The only questions are, how does the method work in practice, and what does it cost? With regard to these questions, a little consideration will show that certain drawbacks and difficulties may readily crop up, which may perhaps not be so easily surmounted. Thus, excessive arcing might take place between the fuel and the iron bars of the grate, which would cause their speedy destruction. Again, it is clear that the resistance of the circuit must be exceedingly variable, as it depends on the quantity, quality, compression, together with the cold or heated condition, of the conducting fuel; consequently a very heavy current might pass at one time and break the magnetic or other suitable cut-out—which should without fail be employed; at another time the current might be too weak to effect the desired object, and time, in addition to electric energy, would thereby be lost; and finally, assuming these points to be insignificant difficulties, there has to be considered the cost of the current, the time, and the personal attention necessary for the operation, each of which items might render the method, with all its advantages, entirely impracticable.

Assuming, however, the possible drawbacks above enumerated to be satisfactorily disposed of, there exist undoubted points in favour of the electric method of lighting fires. The simple operation of shoveling in of the fuel, the mere turning on of a switch, the production of a well lighted fire in a very short space of time, instead of having to wait for the fire to burn up by the ordinary method, are all obvious advantages in its favour. Moreover, the actual lighting is not the only service that is possible, for a ready means of revivifying a declining fire would always be available.

A description of some experiments of the simplest and most elementary nature made in this direction in the laboratory of Mr. J. W. Swan, which was very kindly placed at the writer's service for the purpose, may be found of some small interest, not so much for the slight degree of success which attended them, as to their indicating the conditions by which more complete success may be attained.

The experiments were carried out in a small rectangular stove, containing, when ordinarily charged with coke in small pieces, about 3 lbs. or 4 lbs. weight of this material. The bars and grate formed one pole, and an iron plate, some 5 inches long by 3 inches wide, supported against the fireclay back of the stove, formed the other one. A switch, and an ammeter, reading from 20 to 100 ampères, were included in the circuit. The total available electromotive force was 50 volts. On switching on the current, miniature and short lived arcs formed in various directions, and the general effect was both pretty and interesting; but the total current was usually less than 20 ampères. By pressing on the fuel with a poker, the resistance could be readily diminished, and a current of 20 to 30 ampères would, by this means, be indicated. As the fuel becomes heated, the resistance becomes so far decreased that at times the current will reach 30 or 40 ampères without external pressure; but it seldom remains at this point for more than a few seconds without falling off again to an insignificant amount, unless the fuel is stirred, or renewed pressure is applied. When the fire is well lighted and heaped up with fuel, the current sometimes rises to 80 or 90 ampères without any additional pressure.

The time occupied in properly lighting the fire with 50 volts and under the conditions above described, was usually 10 or 12 minutes. Now, taking the cost of electric energy at 7d. per 1,000 watt hours—as it is to be supplied by the Deptford central electric light station—the expense of lighting this experimental fire, assuming an average current of 30 ampères, calculates out to be about $1\frac{3}{4}$d. to 2d., which, of course, is a prohibitive price. But it is clear that during a space of 10 or 12 minutes a very large amount of heat, obtained by this expensive means, must have been dissipated

and so wasted. If, however, the requisite heat be generated in a very short time, half a minute for instance, this attendant loss would occur to but an inappreciable extent. So that by simply raising the E.M.F., far greater economy may be safely predicted.

Unfortunately the writer has not the means to try experiments under more favourable conditions, and he therefore concludes by leaving the matter in the hands of those who possess the necessary resources, and he, moreover, expresses the hope that they may develop to a successful issue this new application of electric energy.

It need hardly be added that ultimate success does not necessarily lie in exactly the lines above indicated. Mr. Swan has suggested that perhaps some arrangement of a fire clay tube filled with powdered plumbago and rendered incandescent by passing a current through it—the tube being either fitted permanently into the fire, or made as a movable article to be introduced or removed at pleasure—might prove to be a practicable method. Some such plan would have the advantage of being more easily made serviceable through a long range of E.M.F. than in the case where the variable resistance of the fuel of the fire itself is made use of, the length and thickness of the tube being varied to suit the particular requirements of the installation.

A SYNTHETIC STUDY OF DYNAMO MACHINES.

(*Continued from page* 568.)

V. MAGNETIC FIELDS IN PRACTICE.

WE saw in our last article that an induction of 15,000 could be produced in annealed wrought iron by a magnetising force of 25 ampère turns per centimetre, while for similar induction in an air gap no less than 12,000 ampère turns per centimetre, or 480 times that for iron, was required. Now, we must have in the magnetic circuit of every dynamo gaps which are not filled with magnetic material in which the conductors generating the current have to move. Though these gaps are filled partly with air and partly with copper, it may be assumed for the purpose of calculation, since copper has about the same magnetic susceptibility as air, that they contain air only. The shorter the magnetic circuit the smaller is the magnetising force required, and these figures teach us that especially should the air gaps be as short as it is possible to make them ; also when the design of the machine permits, the induction through the gaps should be diminished as much as possible by increasing their cross section. In this way the magnetising force necessary to produce a given number of lines through the circuit is diminished.

16. *Examples of Practical Fields.*—The simplest magnetic circuit, constituted partly of iron and partly of air, is shown in fig. 44,* this being a bar of iron bent round so as to form a ring with a small gap in it. On this ring is wound a magnetising coil, and since the lines of force run from pole to pole through the gap, we have there a field in which we could generate a current by the movement of a conductor. As a development of this rudimentary field let us pass through a coil, A, fig. 45, a number of iron wires and bend them round so that their ends nearly touch each other, as shown. Between each pair of ends, as at N, S, there is passing in the gap a number of lines of force, and we arrange the iron wires so that, looked at from the end of the coil, they lie in a circle like the spokes of a wheel, with the gaps formed by their ends equidistant from each other. By these means there is produced an intermittent field, as sketched in fig 31,† where lines of force flowing in the same direction are grouped in bundles, each group being separated by a space in which there is an absence of lines. These groups lie in a circle, and if a coil is caused to move in a circular path and pass between the pairs of poles in succession, it will have induced in it an E.M.F. which changes in direction each time the coil is directly between the poles N, S, as at B, and each time it is in a position midway between the two adjacent groups of lines as at C. For each revolution the number of reversals will be equal to twice the number of groups of lines.

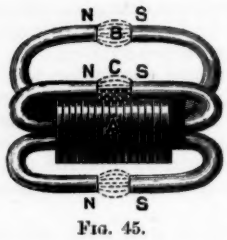


FIG. 45.

The sketch in fig. 45 is merely a diagrammatical way of representing the ingenious field magnet designed by Mr. W. M. Mordey for his alternating current dynamo, the exact shape of this magnet being shown in section and end elevation in figs. 46 and 47. The magnet consists of a massive cylindrical iron core, B, on which is

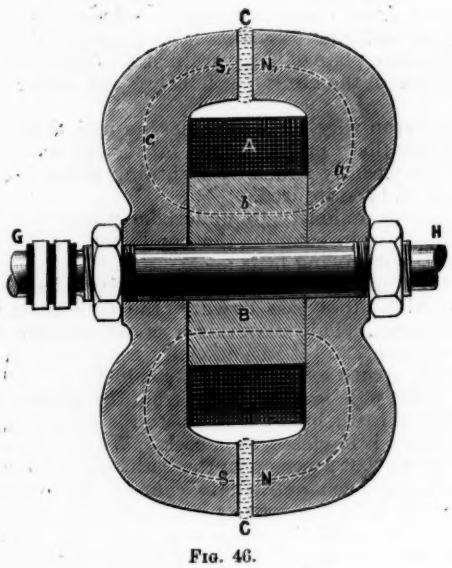


FIG. 46.

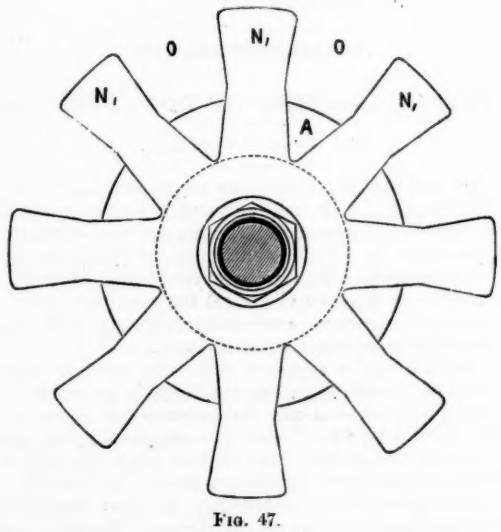


FIG. 47.

* Page 568 *ante.*

† Page 369 *ante.*

wound a magnetising coil, A. Against each end of the cylinder is placed a cast iron piece having eight spokes or horns radiating from the centre, and bent over so that the polar faces approach closely to each other, leaving only the small gap shown at C. There are eight N poles, N N_1, on one side of the gap facing eight S poles, S S_1, on the other side, thus we have produced an intermittent field where there is a number of groups of lines in the same direction as at N, N, N, fig. 47, separated by spaces in which there is no lines, O . O. This magnet may be considered as having a magnetic circuit of the length shown by the closed dotted curve, N_1 *a b c* S, and having settled the induction we require in the air gap, C, and the induction in the iron, the magnetising force in ampère turns can be

FIG. 48.

easily determined by the rules already given. From the shape of the magnet it is necessary that it constitute the revolving part of the machine, the whole being mounted on a spindle, G H ; hence the armature is a fixed series of coils, fig. 48, which are arranged in a

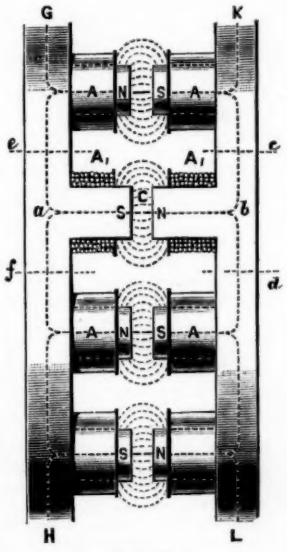


FIG. 49

circle and lie in the gap between the polar faces. In the fig. 18 coils are shown to suit a field magnet with nine horns. For a field magnet having eight horns a sixteen-coil armature is required. The machine will be described in detail in the proper place.

If we desire a field in which the groups of lines lie in alternate directions the construction shown in fig. 49 has to be adopted. Here we have two flat iron rings lying parallel to each other, of which parts G H, K L are shown. On these rings are projecting cores, which may be of wrought iron and attached by bolts, or of iron cast in one with the ring. These projections face one another, and on each is placed a magnetising coil, A, in which the current flows so as to produce in the several cores the polarity marked in the fig. We have thus arranged in a circle and equidistant from each other a group of lines in one direction and a group of lines in the other direction, alternately ; and a coil moved across such a field will have induced in it an E.M.F. which changes direction every time the coil is between a pair of poles. In one revolution there will be as many changes in the direction of induction as there are pairs of magnets. In a machine having a field of this kind the rotating armature consists of a series of coils arranged in a circle round a spindle lying concentric with the flat ring side frames. There is here no longer the single magnetic circuit, but instead a number of adjoining circuits, as shown by the dotted lines. Considering any pair of coils, A A, A_1 A_1, it is evident they must furnish together sufficient magnetising force to create the requisite induction through the air gap, C, through the cores, *a* S, N *b*, from *a* the induction towards G as far as *e*, and towards H as far as *f*, and from *b* the induction towards K as far as *c*, and towards L as far as *d*, each opposite pair of coils having to furnish a similar force. The difficulty in calculating this force lies in the fact that in this type of machine great numbers of lines pass between the adjacent sides of the magnets without going through the gap in which the armature coils move. In other words, we create a field of which we can utilise only about 50 per cent.

These fields are adapted for machines without iron in their armatures, and we have now to consider the character of the field when the armature conductors are wound on an iron core. Following the general plan of these articles, we begin with the simplest form. In a former number* we considered the E.M.F. induced in a loop rotating in a uniform field, the question now arises, how is this field to be produced? If we take a magnet, fig. 50, and bore out a gap for the loop to rotate in, as shown, two very objectionable features are at once apparent. The first is that owing to the great length of the air gap the magnetising force required is enormous ; the second is that as a result of the proximity of *p p* and *q q*, the lines are most dense between those points, a large proportion of them passing between the poles without going through

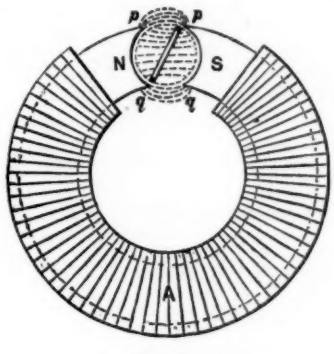


FIG. 50.

the loop, and without being, therefore, useful. These two faults can be remedied by filling up the hole with an iron core, winding the loop over it and allowing the core to rotate. This is shown in fig. 51, where S, D, N is a single horse-shoe field-magnet having two magnetising coils, A, A. The armature core, B, consists of a number of thin charcoal iron discs threaded on the spindle, C, and carefully separated from each other

* Page 302 *ante*

by paper. It will be noticed that instead of the single loop shown in fig. 50, the fig. shows conductors wound over the whole surface of the core. We shall not at present consider how these loops are wound, or how joined up to each other. Nor shall we say why the core is built up of plates instead of being solid. We only draw attention here to the method of producing the field. The function of this iron core upon which the conductors have been wound is first to reduce the magnetising force to a minimum by filling up with iron as much of the magnetic circuit as possible, secondly, to give the lines the direction we wish them

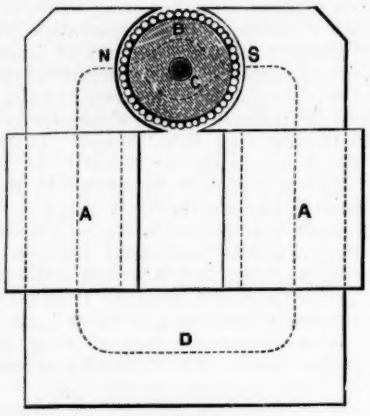


FIG. 51.

to have by guiding them right through the coils. The lines straying outside the core are comparatively few and the field through the loops is now practically uniform. A dotted line is drawn showing the mean length of the magnetic circuit. We know that the E.M.F. induced in a coil is proportional to the lines of force enclosed by it, and when conductors are wound on an iron core the E.M.F. is necessarily proportional to the lines passing through the core. In such cases our object is to magnetise the core, and the total magnetising force required is obtained by adding together the force necessary for the induction in each separate part of the circuit. Knowing the induction in the core, and the mean length of the path the lines take through it, we arrive at the magnetising force required for the core alone. Having the induction in the air gap, and its length, which is equal to the difference between the bore of the magnet and the diameter of the core, we determine the magnetising force required for the gap. Finally we determine the force for the magnet, and, adding the whole together, we obtain the total ampère turns required.

(*To be continued.*)

COMPOUND-WINDING PATENTS.

KING, BROWN & CO. *v.* ANGLO-AMERICAN BRUSH ELECTRIC LIGHT CORPORATION.

(*Continued from page* 605.)

Mr. SAMUEL ALFRED VARLEY deposed in reply to Mr. GRAHAM MURRAY that for many years he had devoted his attention to and been familiar with electric and magnetic apparatus. In 1852 he joined the Electric International Telegraph Company, and in 1859 he took charge of the various stations of the London district of that company. He had had an elder brother, C. F. Varley, who devoted his attention to the same subjects. At that early period his brother brought out a galvanometer with two insulating wires and a magnetic needle.

I suppose that long before that it was known that if you passed currents through wires wrapped round cores of soft iron you would make magnets of them?—Certainly.

Was it also understood that different effects would follow if the wires were of different resistances?—Yes. From the year 1861 to 1866 witness had tried to make a self-exciting machine.

In 1866, I believe, you, in conjunction with your father, Cornelius, managed to make a self-exciting machine, for which you took out a provisional specification, number 3,394 of the year 1866?—Yes, it was really my own, for my father was a very old man then.

That is the machine referred to in line 25 of the specification of the patent which we deal with in this case, namely, your patent of 1876?—Yes; that machine is now in the South Kensington Museum. I was awarded the gold medal in 1885, of the Inventions Exhibition, for having made the first self-exciting dynamo.

Now I pass to the year 1876, which was the date in which you took out the patent in this case. Generally speaking, what was the condition of the knowledge and practice of the electrical world in 1876, when you came to your discoveries as regards incandescent lighting?—There was no incandescent lighting at that time.

The principle, I suppose, was known?—Yes, it was known more than 20 years ago.

It was known that you could produce incandescence by passing electricity through a metal circuit?—Yes.

In 1876 had a suitable material been discovered for producing the incandescent light in a suitable lamp?—No, the only electric light really known was the arc light. There were various forms of arc lamps at that time.

The general principle was the touching of carbon points and the separating of them to a small distance?—Yes.

In 1876 you brought out your patent, of which we have a specification here?—Yes.

That patent, as a provisional specification, is dated 19th December, 1876, and the patent is sealed on the 23rd March, 1877?—Yes.

That describes, among other things, a certain method of winding the magnets of a machine?—Yes, upon page 8.

According to your view, what method of winding is there described?—What is known as the series-shunt.

Have you any memorandum of anything you did at the time that you were making the investigations which resulted in your taking out the patent?—I have a rough sketch in my private note-book.

I ask you to produce it.

The DEAN OF FACULTY (Mr. Mackintosh) objected to this. He maintained that a drawing or memorandum might be used for the purposes of anticipation, upon two conditions, first, that it should be published, and second that notice should have been given of the publication. Neither of these conditions were fulfilled in this case. The object of the production could only be to qualify the specification, and for that purpose he submitted it was not allowable, because the specification must be construed by reference to its own terms, just the same as any other document. The machine was the only thing which was said to be publicly used, and it must speak for itself like the specifications.

Mr. GRAHAM MURRAY, in reply, said he did not put this at all as affording any light on the specification. What he held he was entitled to show was for the purposes of the case as connected with this machine. He should, perhaps, have first asked Mr. Varley how the machine was constructed. But a machine might be constructed, and it had been proved that there would be no difficulty in connecting it to work as a series-shunt. Mr. Varley would say that was now done. It was a very material and relevant point of evidence to show that Mr. Varley's private memorandum was dated from that time. It would be a strong corroboration of the truthfulness of the statement he would make. The machine did not speak for itself.

The DEAN OF FACULTY said it was not competent to show by a diagram what kind of machine Mr. Varley had at some period intended to make. He might have intended to make a compound wound machine and not have made it.

Lord TRAYNER said the Dean of Faculty had raised a doubt as to what the machine here described was. Mr. Murray intended corroborating Mr. Varley's statement that it was a series-shunt, not only that it was intended, but that it was so in point of fact, and he offered to show a memorandum made at the time to prove that his statement was no afterthought. After further discussion Lord Trayner allowed the question, but suggested that Mr. Murray, before putting it, should ask about the machine itself.

Mr. MURRAY, resuming examination of the witness, asked, Did you have a machine constructed in accordance with your specification?—I did.

Is that the machine?—(Pointing to it where it stood on the floor.)—Yes.

Where was it made?—It was made by Siebe and Gorman, Westminster Bridge, London. It was commenced in the latter end of 1876, and completed, as far as I remember, in the early summer of 1877.

When it worked the electric light how was it connected?—As described in my specification, as a series-shunt machine.

When did it first work?—As near as I can remember in the later spring or earlier summer of 1877.

Have you any memorandum which helps to refresh your memory as to how that machine was connected?—I have.

Was the memorandum made at the time?—It was made in November, 1876, before the specification was lodged.

What is this book (showing it to the witness) which is dated on the outside, 1864?—It is simply a book in which I made private notes of all sorts of subjects in which I was interested.

Does it contain notes or adaptations or anything of that sort which were made at the time?—Yes, it contains, generally, notes of anything I thought important at the time.

You now call attention to page 56?—I do.

What do you find there?—I find a description of a series-shunt machine, and on page 58 there are some other thoughts on it.

Is the machine you were there describing the machine that you were engaged in inventing at the time you were thinking of taking out your specification?—It is. The commutator was slightly altered, as described on page 58.

There is a diagram on page 56; what is indicated by it?—A series-shunt machine. The notation is of a form known by all electrical engineers.

Is this machine now in Court connected in just the way that is represented by that diagram?—Exactly in that way.

Turning now to the specifications, what were the several well-known ways of doing this that you knew of?—The first was that which was adopted in the first machine which I made, in 1866. In that machine I used what is known as a series machine, and also a shunt machine. There was also the way Wilde adopted, in which he had two commutators and used a certain number of bobbins, in which the currents were developed in alternate directions, but which were converted into a uniform direction by the commutator, and went round the field magnets. The other bobbins were connected with another commutator, and the currents were developed in alternate directions. This was for the purpose of the electric light.

That is to say, one portion of the electricity developed by the bobbin was taken to make a shunt, practically?—Well, it was a double machine.

Yes, one portion of the electricity developed by the armature went to maintain the magnetism of the magnets and the other portion went in alternate currents to make the light?—That is so.

You then proceed to describe a method which you prefer, and which you have already told us is series-shunt winding?—That is so.

Was the Gramme machine invented at that time?—Yes, I should have mentioned that as one of the other well-known ways. The Gramme plan had six field magnets; one pair of these excited the bobbin and sent the current over the electro-magnets, and the other pair of bobbins revolved between the magnetic fields produced by the other four, and the current for lighting was thus got.

That was a case of separate excitation in the same machine?—Yes.

But the method you preferred was that which you say is series-shunt winding; how did you not claim it in the patent?—When I was drawing up the complete specification I thought it advisable to consult the *Philosophical Magazine*, in which there was an account of the papers read by Sir Charles Wheatstone and Dr. Siemens, describing their independent discoveries of the dynamo principle, and I found in the same magazine (while those papers were read in February) that there was another paper in March, read before the Royal Society by my late brother, C. F. Varley, and he suggested that the shunt of Wheatstone's which did not maintain the field of the permanent magnets, should be wrapped upon the field magnets themselves, so that the electro-magnets should be utilised. And it seemed to me at that time, though my brother had another purpose in view, that he had left me very little to claim.

In other words you came upon a communication which you thought, rightly or wrongly, was very like the principle of series-shunt winding?—Yes; I consulted my patent agent, but, of course, he was not a scientific man.

Lord TRAYNER: The result was that you did not claim?—Yes, and I left it.

Mr. MURRAY: Do you say that at that date, when you made and when you were making this specification you understood the electrical significance of series-shunt winding?—I did do so.

I ask you this—your specification goes on to describe a certain form of lamp for arc lighting?—Yes.

Was the series-shunt winding necessary, or, at any rate, highly useful for the lamp?—It was absolutely necessary for the lamp.

Would the lamp have been equally successful if you had used either of the well-known ways, namely, plain series or plain shunt?—No, it would not have worked with either. The lamp I used was not of my patent, but it was well known at that time and worked successfully.

Cross-examined by the DEAN OF FACULTY.—The machine produced was made under my patent at Messrs. Siebe & Gorman's works. I was a partner of the firm at the time—only in respect of my patent. This is not the only machine made under my patent. There was a small one constructed experimentally. I do not know what has become of it. The machine produced was worked in Messrs. Siebe & Gorman's works. It was worked on one occasion for photographing an ice machine, and again to show it to some friends of the firm who took an interest in the machine. I cannot say that it was worked more than once to light up the ice machine. Speaking from memory I would say that my machine was worked within a month after being finished. The photographer, the foreman of the works, the workmen in the place, Mr. Siebe, and, perhaps, Mr. Gorman, were present on the occasion of photographing the ice machine. I know that the machine was used for this purpose, because I was told by Mr. Siebe and the foreman of the works. Mr. Siebe is not alive, but Mr. Gorman and the foreman are and are here. I cannot say where the machine was put, but it lay in the works. I ceased to be a partner of Gorman's when my patent was discontinued. I was a partner for three years, I think, after 1876. I was going about the works frequently during that time. I have seen the machine used again and again. The machine had to be worked frequently in order to bring it to perfection, but I cannot admit that it was altered very materially.

His LORDSHIP: Was it altered more than once?—There were some slight mechanical alterations, from electrical reasons, which developed themselves; it had to be made right mechanically.

By the DEAN: I cannot say when I last saw it at work. It would be some months after it was completed, I think. After this the machine was not altogether set aside. I carried on some other experiments particularly upon it, and in making other machines. These experiments were made up to 1878, and after this the machine stood in the workshop. It was doing nothing. I saw it up to 1878.

His LORDSHIP: He says he only saw it worked once. It is obvious that the thing was laid aside as a useless thing and not used.

The DEAN: Did it remain until it was produced for the purpose of the Crompton case?—Yes.

His LORDSHIP: It is quite obvious the thing was not a success, and was kicked aside, and was turned up to be produced in process. I gathered that long ago. (Laughter.)

The DEAN: Now you have told us about this machine. Did you ever sell a machine made in terms of your patent?—No, that was the only machine made.

His LORDSHIP: You can sell it now. (Laughter.)

The DEAN: Were you trying to make other machines in terms of your patent?—Not under that patent.

His LORDSHIP: In short, it was not a success and did not take the market and he dropped it.

The DEAN: Is there any diversion of electric current in the series machine?—There is a diversion of the electric energy.

Then your reading of the word electricity is that it meant electric energy?—Certainly.

His LORDSHIP: Do you know any difference between the terms electric energy and electric current?—No, I do not.

The DEAN: Therefore you think you were not mistaken in saying the series machine served this purpose, and that that part of your specification was applicable to the series machine whether it means electric energy?—There is certainly an amount of energy diverted to maintain the magnetic fields of all dynamo machines. The shunt machine was well known and Gramme's and Wilde's machines were sold.

Now, in 1876, was the shunt machine known in the market and asked for, or was it merely described in a paper read before the Royal Society?—It was also publicly known, because it was in common use at the British Telegraph Manufactory, of which Sir Charles Wheatstone was chairman. Sir Charles Wheatstone's machine was constructed about 1876.

Was there any dynamo machine constructed on the shunt principle and used prior to 1876?—Yes, at the British Telegraph Manufactory. It was used for the purpose of separation of magnetic ores from anti-magnetic ores. I used a Gramme machine as a shunt machine in 1874.

Were there any other machines on the shunt principle so used to your knowledge?—I am inclined to think the shunt machine was of common knowledge at that time.

This being a well-known machine you thought you had invented a new machine which was not well-known?—I did.

And you regarded compound winding as an important matter, I suppose?—Yes, I did.

A very useful and important discovery?—Yes.

And you quite understood the system, I suppose?—I understood the general electric principle of it.

Knowing its importance what was your reason for not claiming it as a part of your invention?—When I said I knew its importance that statement wants qualification. I did not know of the full importance of the principle.

You knew it was so important that your lamp would not work without it?—My lamp would not work without it. I did not claim the invention for the reason that my brother had read a paper before the Royal Society describing a mode of working which I thought was an anticipation of my patent. My brother's communication was made to the Royal Society in 1867. The passage which excited my apprehension was as follows:—"The force expended in the shunt is wasted in heating, but a secondary wire on the electro-magnet, or a copper cylinder, would very greatly add to the power by maintaining the magnetism, and not consuming uselessly the force now wasted on the shunt." My apprehension was that my machine might give good ground for litigation on the part of my brother. My relations with my brother were strained at the time.

The DEAN (handing witness a paper): Is that a rough drawing of what your brother proposed?—No, that is not my brother's.

Is not there a secondary wire in the electro-magnet, in addition to the shunt. Is there anything in the passage you have read to suggest that that secondary wire was to be excited by an electric current passing through it?—My brother's description offered two alternatives. This is practically the same thing as a copper tube. There is nothing in my brother's description to say that the current from the armature passes through the secondary coil.

And yet you were afraid that that description was compound winding?—I was afraid it would lead to litigation in the matter of series shunt winding.

Was not the reason of your not claiming the invention that your machine was to be worked on the principle of self-excitation, similar to the Wilde and Gramme machines?—Mine was not excited on the same principle.

Lord TRAYNER: Did you abstain from claiming what is described in your specification as an invention of your own, because Gramme and Wilde had anticipated what you were really describing?—No; certainly not.

The DEAN of FACULTY, resuming: Now, in that patent you described a machine which was constructed for the purpose of separating the development of the electrical and magnetic forces to a considerable extent. Do you now say that that is practicable?—You are talking of a theory of mine.

Do you still adhere to it?—I do not understand you.

His LORDSHIP: Do you think, now, it is possible to separate the development of the electrical and magnetic forces to a considerable extent?—Yes; I do.

The DEAN: Do you still consider that you thereby increase the magnetic potential in the bobbins?—Yes.

Do you still think that that increase becomes, at a later stage, converted into electricity?—I should be doubtful now whether I was strictly correct about the sum total of energy.

Was not that the main object of your machine?—My main object was to get a greater amount of energy.

Do you still think it possible to use three sets of bobbins as proposed in that passage?—Yes.

Did you ever see or hear of a dynamo machine where there was an odd number of groups of bobbins?—No, I think not.

Now, you took a great interest in the recent litigation with Messrs Crompton?—I did.

And you were very much disappointed when that case came to an end?—I was disappointed.

And I believe you wrote to the solicitor of the company, expressing surprise that they had not faith enough to fight the case?—I did.

Upon the Messrs. Crompton declining to fight the case, did you ask an interview with Mr. Sellon, the vice-chairman of the Brush Company?—I asked him to give me an interview without prejudice. I had an interview.

And did you propose that if the Brush Company would give you a certain salary you would make it impossible for anyone thereafter to challenge their patent?—No, I did not.

Did you propose that the Brush company should take you into their service and give you a salary?—I stated to Mr. Sellon that my friends had urged me to see him; that I had a considerable sympathy with the shareholders of the company; that I held a sort of goodwill, although I had lost my patent rights; and that if they choose to make any offer which my friends considered I might honourably accept, I should not publish an account of what I had done in the ELECTRICAL REVIEW, and that I should give them what assistance I could.

After the interview, did you receive a letter from Mr. Sellon?—Yes.

The letter is dated December, 1887, and is as follows:—"As I told you, we are unable to recognise in your specification any point which bears upon our rights in this matter. But whether this were so or not, our acceptance of your candid suggestion that the Brush company should purchase your silence, and thus, in your opinion, safely secure our royalties by giving to you a salaried appointment, as such would not for a moment be entertained." Do you repudiate the construction which Mr. Sellon put on your proposal?—I do.

The witness then read his reply, which contained the following: "Acting on the advice of some of my friends I wrote to you, and had you seen your way to make any offer, which you do not see your way to do, such as my friends and I considered I could honourably have entertained, I should have recognised that I was selling part of my birthright for a mess of pottage." (Laughter.)

You stated in your letter that nobody had the power to contest the claims without your assistance and assent?—That was my opinion at that time and my assistance was certainly of considerable weight. My specification was published.

If your object was to contest the Brush patent in respect of your specification, how could they require your assistance and advice?—Technically they would not. His machine had been shown at Siebe and Gorman's works and the public had seen it at work there.

How then do you say that nobody had it in their power to contest the Brush Company's claims without your assistance?—Technically I was wrong; that is my only explanation.

Re-examined by Mr. GRAHAM MURRAY:—You said that eventually your machine did not come to be worked and was laid aside; what were the defects that prevented it being used?—There were no practical defects. The machine was somewhat imperfect as first machines usually are, but it was not developed simply because I could not get pecuniary assistance from my partners.

Why was the particular machine which was used for a certain time in Siebe and Gorman's works not used?—A dissolution of partnership was taking place at the time between Siebe and Gorman. The non-use of the machine did not arise from any action on my part. The machine was altered from time to time, but it was not altered from what it was at first so far as the electric part was concerned and the series shunt winding. The machine was put aside and was never produced again until the Crompton case. Edison and the Brush Company wished to buy the machine but he would not sell it.

Mr. MURRAY: The Brush Company would have probably kept it in a glass case. (Laughter.)

The witness stated that struts were necessary to counteract the effect of the increased magnetism developed during the burning of the arc lamp. He did not foresee the possibilities of his machine, or only very vaguely, which ensued afterwards from the incandescent light being found out. There was never any concealment of the machine after it was worked in Siebe and Gorman's shop. His partnership with Siebe and Gorman only related to the joint interest in the royalties of the patent.

The witness's examination was then concluded and the Court rose for the day.

Thursday, November 29th.

The first witness called was W. A. GORMAN, partner of the firm of Siebe & Gorman, engineers, London. In answer to Mr. Dickson he deposed that Mr. Varley's machine (which that gentleman had described on the previous day as a series shunt machine) was made in the firm's works in 1877.

Cross-examined by the DEAN OF FACULTY, he said the machine was used in his works in the end of 1877. It never left the works. After that year it was placed in a store and left there.

Was that a place where old and useless machines were put aside?—No, it was simply for tools.

Was it searched for and bought up for the purpose of the Crompton case last year?—Yes.

Was Mr. Varley from time to time making alterations on the machine?—Not that I am aware of. The machine was made in the latter part of 1876 or the beginning of 1877. The machine was used twice for lighting for experiments with a diving bell.

Mr. DICKSON: Were these experiments being made for your ordinary marine engineering business?—Yes.

EDWARD FRANCIS MYERS deposed that he was foreman with Siebe & Gorman since 1876. He had a rudimentary knowledge of electricity and engineering.

Have you any practical experience of shunt and series winding?—Only in the construction of this machine. I constructed this machine in the beginning of 1877 under the instructions of Mr. Varley. He left the mechanical part to me.

As the machine was first made had you this driving pulley on it?—No, a much smaller one.

Were these strips of gun metal binding the two sides of the machine together there at first?—No.

Was this double core bearing here?—No, not at first.

With these exceptions, is the machine just as it was when you made it at first?—According to the electrical arrangements it is exactly the same. The machine was used on six or seven occasions. Five or six times it was used to get the machine mechanically improved, and on one occasion it was used for a light to photograph an ice machine.

How many wires were there from the machine?—One circuit.

Did you put your keys near the armature?—Yes.

And when the light was on, did the keys show you that there was magnetism in it?—Oh yes.

Was there any change when the light was burning?—Yes, the magnet power was much increased the moment the arc was formed.

How did that show itself?—By pulling the keys more violently.

Had it any effect on the machine?—Yes, it pulled the machine up by causing the two groups of field magnets to close in on the armature, and it threw off the strap from the fast and loose pulleys. Alterations were then made on the machine, and the larger pulley now attached was put on, but it still gripped. I then attached those pieces of gun metal, and they were successful in preventing the field magnets gripping on the armature. But there was still a shivering of the armature.

What did you do then?—I made that double core bearing which is now attached.

Were these objectionable features present only when the electrical circuit was closed, and did they cease when it was open?—Yes.

Did you try the machine once without the fine wire being on?—Yes, and the result was that the light was not nearly so good.

Except those mechanical alterations of which you have told us, were there any alterations made on the machine?—None as regarded electrical arrangements. It was an arc light that was used.

Was there any secrecy about the construction or exhibition of the machine?—None whatever. Several workmen were employed about it; several of the firm's friends came to see the light when it was in operation.

Can you tell me how the commutator was made?—There is first a wooden foundation, a hub or bush for insulating purposes, a gun metal base permanently fixed, and a steel plate which can be detached from the gun metal base.

Is the word hub quite commonly known in your work?—Yes, it was cylindrical in form.

I show you two parts?—Yes; that is the inner permanently fixed piece, number 45; and this, number 46, is the detachable piece for renewal.

Cross-examined by the DEAN of FACULTY.—There might have been other alterations made on the machine besides those witness made. There were four screws or terminals for the purpose of shifting about the wires. Having these terminals, the machine was capable of being coupled up or connected in different ways. The machine was laid aside from 1877 to 1887, when it was unearthed for a case last year. It was kept in the metal store.

Could any one have seen without tracing out the connections how the machine was coupled up at any particular time?—No.

You never did trace it out?—In arranging the polarity of the fields under Mr. Varley's instructions I had to do that.

Was there more than one lamp used?—Yes; the first was an

improvised lamp, and then the Breguet lamp was used, and afterwards the Serrin lamp, which is produced here.

By Mr. DICKSON.—The Breguet lamp required a different current from what this machine gave, but the Serrin lamp was the proper thing.

Cross-examination resumed.—It was a long time since witness had seen the commutator till now. The parts produced formed only one strip of the commutator. The connection between the segments was not a rivet nor a screw, but a combination of both. It was a screw rivet, and had no ordinary rivet head, but had only a slight burring at the top. The gun metal face was first secured the hub with wooden screws, and then the wearing segment wa sattached to the sub-segment by the screw rivet.

FREDERICK JOHN GARNISH, examined by Mr. GRAHAM MURRAY, said he was works manager to Siebe and Gorman. He entered their employment in 1873, and was appointed manager in 1876. He had known Mr. Varley since the latter date. He remembered him coming to the works about this machine, and he remembered the machine being made. It was made to a certain extent under his superintendence. The machine was marked, and the lamp, number 42, produced (the Serrin lamp), was the one used.

When the machine was working, how many wires were there from the machine to the lamp?—Two.

Are you certain about that?—Yes.

No more?—No more.

Did you try any other lamps?—There was a rough temporary lamp, and there was another one, the Breguet. This Serrin lamp here was the last one, and it worked satisfactorily.

When the lamp was lighted and the machine was running, did you notice the effect on the magnetism of the machine?—I noticed that the magnetism seemed much stronger when the light was on than at other times. I noticed that by holding a bunch of keys near it.

Did you notice that they were attracted when the lamp was out?—Yes, but not nearly so much. I noticed also before the lamp was lighted a slight sparking at the commutator.

Did you find when working that the machine bound at all?—Oh yes. We had several times to take the machine to pieces, and had to put in these stay pieces of gun metal to prevent the machine from going to pieces. The machine was worked quite openly, nearly opposite the entrance gates. I remember it being used for a light for photographing some ice machinery. It was also used to light up a diving tank in the centre of the works, so that people could see a diver inside experimenting with his dress.

Cross-examined by the DEAN OF FACULTY: The machine was put away into the store by witness's instructions, because it was in the way. It was put into a corner, and taken out when the Crompton case came on.

Do you know that the Brush Company were very anxious to see t?—Yes.

Did your people refuse to show it to them except on payment of £100?—I do not know.

DUNCAN CARMICHAEL, in reply to Mr. MURRAY, said he was an instrument maker in Glasgow, in the employment of James White, optician. He was called on recently by a gentleman and given a copy of Varley's specification. He was asked if he could, from its instructions, make a model of the machine there described.

At that time did you know anything practical about dynamos?—Nothing whatever.

Did you know anything of the difference between shunt, series, and compound winding?—I had heard the terms, but knew nothing about them. I had never made a dynamo nor assisted to make one; I took the specification and proceeded to work.

Is that what you made? (Shown a model, number 38)—Yes.

Did anyone help you?—Nobody. It was sent to the defenders in this case.

Cross-examined by Mr. JAMESON: What instruments are you in the habit of making?—Ampèremeters and voltmeters.

You are accustomed to the system of electrical connection?—Yes.

Had you ever occasion to fit on these meters to dynamos?—No.

You have seen dynamos?—Yes.

And seen how the winding round them was done?—I never examined them minutely. I have read very little about them. I have studied magnetism and electricity in Anderson's College, Glasgow. I was there two sessions. No models of dynamo machines were exhibited at the classes, but electro-magnets were shown. I have never seen magnets with two coils round them, but I have seen induction coils.

Lord TRAYNER: Is this the first model of an electric machine that you have made from a patent specification?—Yes, the first.

And you have made it simply from the terms of the specification and the drawings appended to it?—Yes, entirely.

HUGH HOLMES MCTAGGORT, examined by Mr. GRAHAM MURRAY, said he was an apprentice with Brown Brothers & Co., of Glasgow. Mr. Brown was a common partner of that firm and of King, Brown & Co. Mr. Brown gave him a paper, No. 47. It contained drawings made by Mr. Brown, representing a shunt-wound coil and a series-wound coil. Mr. Brown explained them and told witness to try if he could wind a machine according to the instructions in the paper. Witness made three drawings, and then made the model produced, No. 47.

Cross-examined by Mr. JAMESON.—There was electrical engineering carried on in his employer's works, and he had seen some of the finished armatures, but he had never seen the work being done.

GEORGE D. ANDERSON, apprentice engineer, Glasgow, deposed that he had studied electricity and magnetism for about five weeks. On the 12th of November Mr. Brown called at White's workshop, where witness was employed, and gave him a copy of Varley's specification and also of Clark's. Witness told Mr. Brown that he knew a little about dynamos, but nothing about compound dynamos. Mr. Brown then told him to make a model according to the specification. The model, No. 37, produced, was the one he made. Nobody helped him, and he made it from Varley's specification.

Cross-examined by Mr. JAMESON.—Sir William Thomson's magnet apparatus was made in White's workshop, but witness was not in that department.

Dr. HOPKINSON, recalled and examined by Mr. GRAHAM MURRAY.—Yesterday afternoon this machine of Varley's, No. 29, was opened up to a certain extent to find out what the armature was like in it. What did you find?—Yes, it was opened up, and I found that the armature consists of a cylindrical piece of wood, to which were attached segments of brass connected with the wires of the armature. To these segments of brass were attached, by means of screws, plates of iron, upon which the collecting brushes run.

Now when these two are joined together would the segment of brass be correctly described as a sub-segment?—Yes, in relation to the segment of iron.

What is the use of the iron segment?—The brushes rubbing on the iron segment wear it, and in the course of time would wear it down close to the brass. When that occurs it would be practicable to take away the iron segment and replace it by a fresh one, without disturbing the brass segment attached to the hub. The commutator, the witness also said, was in accordance with the description in the specification of Varley's patent.

In cross-examination, the DEAN OF FACULTY questioned the witness as to the way in which the segments were rivetted, and the construction of the rivet. Like a previous witness, he said that it was a combination of a screw and a rivet, and that the hub was flush with the wearing segment. It was the case that in Brush's commutator the head of the rivet was far down in the wearing segment, so that even after a considerable surface was worn off it held.

JAMES SWINBURNE, electrical engineer, after detailing a large number of positions which he had held as an electrical engineer, said in 1878 commutators were well-known. Most of them had an insulating body on which the segments were placed. It was quite common to have commutators of a cylindrical form. Taking that to be the state of knowledge on the subject, he considered that the invention was simply for putting detachable segments on the commutator.

Pass over claims 2 and 3 in the specification, and come to claims 4, 5 and 6. You will find there claims which mention the insulating segment T. What is the use and object of the insulating segment T?—Its use appears to have been something for the brushes to rest upon; that was insulated from the rest of the commutator.

It was insulated because the brush was idle at the time, and therefore you did not want it to touch the rest of the commutator. Why did you want it to be idle?—If the parts of the armature are connected in parallel you will have to have them idle, because there is no current flowing. If you connect them in series, the segment T will have to be connected with the segment T opposite.

Yes; but what I want is what is the object of having a particular portion of the revolution where there is insulation between the brush and the armature?—Because in that part of the revolution the coil is not giving any current.

Is there any disclosure of that in the provisional specification?—No.

Coming to the seventh claim, as to the dynamo machine, at the date of Mr. Brush's specification what was the condition of the electrical world as regards the incandescent light?—Incandescent light did not come in until long afterwards. Constant potential would be desirable on the arc light as then known. In Mr. Brush's specification he found no hint whatever of exciting to get constant potential. Series shunt winding was disclosed in that specification.

Assuming the machine to be made in terms of the specification and the winding series shunt as there described, would it necessarily follow that that machine would be a constant potential machine?—No. It might be in some circumstances. You have to make the arcs fit the machine, but in the constant potential machine you make the machine fit the arcs. The first thing needed to get the potentiality of the machine was a demand for constant potentiality and then the method to make it, that was by winding in certain proportions.

Is there anything in Brush's specification or drawings to give you the knowledge which is required in order to secure a constant potential machine?—Brush's specification in some ways would mislead. He mentions in one place that the shunt wire may be longer than the series or they may be of the same size. Then he says that the teazer may be wound in two courses. That would be misleading except for very low electromotive force. These are the only parts of the specification I think misleading. As to the drawings I can hardly say they are misleading because it is obvious that these drawings have been made by a draughtsman from a model in the American Patent Office. There was nothing in the drawings to show sufficiently the diameters of the wires and the other conditions necessary. If a workman took them as drawings he would never take them as drawings showing the wires in their proportions. If he took them as drawings for proportions figures 1, 2 and 3 would mislead him. Figure 4 would not give him any definite information. There was far too little volume of shunt and far too little series shown in figure 4. He could hardly

conceive of a machine which would not lose its field in open circuit with so little shunt as that.

Now as to Varley's specification, is there a method of winding disclosed on page 8?—It is clearly a series shunt winding and is a very good description for a workman.

Do you find anything as to the mode of winding disclosed in previous specifications which is not already disclosed here?—I find a pure shunt described in Brush's but it is a well-known form. There was nothing disclosed as to series shunt winding. From the specification it was shown that the current used for the electric light circuit was also by coils round the magnets used for magnetising the magnets. The circuit of low resistance must have been in series with the arc light.

It has been suggested that the method of winding here described might be a method by which there should be separate excitations from different parts of the armature. Is that inconsistent with the specification?—It is not consistent with the description of the machine in the specification. It is shown that the bobbins of the armature are all connected in series, and show that the whole parts of the armature are in connection. This *e* is clearly shown in the drawings also. The series shunt winding was the best winding he could have for an arc lamp. Varley's machine could be connected to work as a series shunt. The wires were too thick to be connected with a double shunt arrangement. It would require to have a different sort of commutator to work a second excitation, and would require to make a curious makeshift in order to work a double shunt.

If you were told that when this machine was used, and when the electric light was on, that the magnetism of the machine was largely developed, what would that indicate?—That would show clearly that the electric arc was in series with the wire of the field-magnets. Mr. Varley's sketch shows clearly series shunt winding.

Cross-examined by Mr. JAMESON: Varley's segments are fastened on with pins, and Brush's by peculiarly shaped screws with long heads?—Varley's pins are screwed at the end, but Brush's have long cylindrical heads. I think when worn down there is very little difference between them in shape.

His LORDSHIP: Is there any practical difference between the two?—Brush's is a little preferable. In the end they served the same purpose.

By Mr. JAMESON: Witness said he cross-examined Mr. Brush in Crompton's case, which took place in America. So far as he knew, Crompton was well aware of Varley's machine and specification. He never heard of a shunt winding machine before Brush's was published. Enormous numbers of series shunt winding machines had been made since Brush's patent was published.

Is it not the case that Brush's drawings show a very much larger resistance in the shunt than in the series winding?—The ordinary shunt machine would in many cases give more constant potential than some of the machines shown here. Compared with a series machine, Mr. Brush's would show more constant potential, but compared with a shunt machine it would not.

Would an ordinary workman be able to find out for himself the proportions from the drawings?—It took the Brush Company five years to find constant potential in their specifications, and I must say I have not discovered it yet.

Is there not a machine constructed that gives actual constant potential?—Practically constant potential, certainly.

Does Brush's machine not tend towards the attainment of constant potential?—If you compare it with the older machine it does; but compared with the shunt machine, it does not.

With regard to Varley's machine, could not one of the three discs be used solely for exciting the magnets?—By altering it you could use one of the discs out of the main circuit, but it would not work very well.

How many terminals are there in a dynamo machine?—There are two main terminals.

Are there not six in Varley's machine?—Yes.

With the aid of these could you connect that machine in almost innumerable ways?—Yes.

Re-examined by Mr. MURRAY.—The effect of drawing together, in Varley's machine, when the arc light is burning, indicates what?—It indicates the existence of a series-wire, which goes through the electric light and winds the magnet also. If he were told that when the lamp was out the brushes spark that would indicate that the field magnets were excited. To alter the commutator of Varley's machine so as to use it for a separate excitation would necessitate considerable trouble.

Professor EWING, Dundee, gave details of his experience in electrical matters, and then Mr. MURRAY asked:—Taking Brush's specification, and comparing the provisional specification—in so far as it describes the commutator—with the claims, do you find any instrument or apparatus claimed in the claims which is not described in the provisional specification?—I do.

Tell me what?—I find that in the claims there is an instrument claimed which consists of a certain combination (that is in claim 3), namely, a combination of sub-segments are wearing segments, S or T, and screws, K. In the provisional specification I find that the only words relating to commutators cover only the claim 2, and that there is no hint in the provisional specification of the combination claimed in claim 3, especially with reference to screws, K, which are a feature of claim 3.

What is the electrical purpose of the insulating segment, T?—The electrical purpose is to disconnect each coil in succession as it passes the pole of the magnet.

Can you find anything in the provisional specification which gives you any hint that an apparatus of that sort was to be devised or claimed?—There is no hint of any such apparatus.

You have seen numbers 27 and 28 of process; what are they?—Number 27 appears to be part of a commutator, but the insulating body is wanting. From the appearance of the commutator I should judge that the insulating body is attached to the shaft of the machine. Number 29 is the insulating body which would complete the commutator.

Does it make any difference electrically whether the attachment is to the shaft of the machine or to the commutator?—Absolutely no difference.

Or if it was loose between the two?—That would make no difference either.

Can that commutator be properly described as a commutator of cylindrical form, having sub-segments in electrical connection and detachable wearing segments attached to the sub-segments?—It could.

At the date of Brush's patent in 1878, were cylindrical commutators perfectly common?—Yes.

Did most commutators have an insulating body attached to them?—That construction was quite usual.

Have you looked at the commutator in Varley's old machine?—I have. The form of that commutator is cylindrical. It has wearing segments detachable and attached to the sub-segments by means of screws.

That portion shown you has been roughly torn off; but if it had been known how the thing was put together, would it have been possible or easy to take off the wearing segments without doing any injury to the sub-segments?—Yes, it would.

You have examined Varley's commutator?—I have.

You are aware that there is a difference as to the electrical connection between it and the electrical connection as shown in Brush's commutator?—Yes.

Is that owing to the difference there is of the arrangement of the coils in the armature?—The principal difference is due to the arrangement of the brushes. It is also in part to be ascribed to the arrangement of the coils in the armature.

Has that anything to do with the question of the wearing segments being detachably attached to the sub-segments?—It has absolutely nothing to do with that.

Passing now to the 7th claim of Brush, and the appropriate description, do you find anything in Brush's patent of his having thought of the desirability of or of trying to obtain a machine which would work with constant potential?—I find no hint of that in the patent

In the state of electric science, especially as applied to lighting at that date, was a machine that would work with constant potential a desideratum?—No.

What made it a desideratum?—The subsequent invention of incandescent lamps, about the end of 1879 or the beginning of 1880.

Turning to Varley's specification upon page 8, you find there described a certain system of winding. Reading the description as an ordinary person would read it, what system of winding does that convey to your mind?—It describes clearly a series shunt winding.

Looking at Varley's machine, what system of winding do you find there?—I find that so far as the magnets are concerned there are two coils for each magnet. That would be compatible with a series shunt arrangement.

Do you find that the machine has been constructed in a way it might have been if it was on the lines of Varley's specification?—Yes.

It has been suggested that the method proposed by Varley in the specification was a method for separate excitation, Reading the specification as a whole, is that your view?—Certainly not; the specification as a whole is absolutely imcompatible with that view.

Upon what passage do you found that?—I found it on the whole description of the grouping of the coils in the armature, and the description in the text taken in conjunction with the figures. The description gives a perfectly clear account of the manner in which the coils are grouped among themselves, of the connection of these coils to the separate parts of the commutator, of the connection of the several parts of the commutator among themselves, and of the connection of the brushes among themselves. This description accounts fully for all the coils in the armature, and leaves no coils which could possibly act to produce separate excitation. It accounts for all the brushes, and leaves no part of the commutator or brushes which could serve to produce separate excitation, even if there had been unaccounted for coils in the armature.

Having felt for the connections of the brushes underneath Varley's machine, can you say how the different sections of the commutator are connected?—I can say that the different sections are connected in series in the manner in which Varley describes in his specification.

Look at sheet 3, figure 17; is the connection which you feel in this machine just the connection which you see delineated in that figure?—Yes, it is identical.

Is that connection inconsistent with the using of a portion of the armature of this machine for separate excitation?—It is inconsistent.

Is there also disclosed in Varley's specification a certain form of lamp for producing the arc light?—Yes.

Would series shunt winding be an advantage for the production of the light by that lamp?—By that particular lamp series shunt winding would be a distinct advantage: in fact, I would go so far as to say that neither simple shunt winding nor simple series winding would have allowed that lamp to act in a satisfactory manner, if it would have allowed it to act at all.

The drawings of the lamp are upon sheet 3, figs. 23, 24 and 25. Tell me what would be the disadvantage if a lamp so delineated was run by a machine which was purely shunt?—When the carbon, T, of fig. 23 made good contact with the carbon, N, the current would be almost wholly diverted from the shunt. The machine would consequently lose its magnetism to a great extent, and over and above that the motor of the lamp would be stopped, the motor being on the shunt circuit.

What would be the disadvantage of running that lamp with a machine arranged in pure series?—If the lamp broke contact between the two carbons as was the case in one form of Varley's lamp, which consisted of an alternate make and break, fig. 24, in that case the machine would stop action entirely and the motor would also stop.

On the other hand, if the lamp would run with a machine arranged in series shunt?—Neither of these two things would happen.

If you were told that when this machine was being worked in conjunction with that lamp—which you see, No. 42, the Serrin lamp—that there were two wires and two only from that lamp to the machine, and that while the lamp was burning there was observed in the machine a greatly increased magnetism from what had been with the shunt only, to what result would that lead you as regards the connections of the machine?—I should conclude from that with absolute certainty that the current which was passing through the carbons of the lamp was also producing magnetism in the magnets of the machine; in other words, that there was a series winding of the machine.

If it was also observed in practice that when the lamp was out sparking was observed on the brushes of the commutator, what would that tell you as to the connection of the machine?—That would show that there was still an electric circuit somewhere through the machine—in other words, that there was a shunt circuit.

Then, if both these things were told you together, to what conclusion would it lead you?—That there must have been both a series winding and a shunt winding; that is a series-shunt machine.

You have told me that you consider series-shunt winding very appropriate and necessary for this particular lamp. Now look at the passage of Varley's specification, which begins upon page 7. Has the first sentence anything to do with series-shunt winding?—No, it has nothing to do with that; it has to do with another feature of Varley's machine, the feature that is common to it and to the Brush machine.

And I suppose many other machines?—No, it is not common to forms of many others. It is one of the many features which are common to the Varley machine and the Brush machine.

It is a matter that arises upon the armature?—Yes.

Was it anything to do with anything else than the armature?—No.

Cross-examined by Mr. JAMESON, witness said the description of the commutator, number 32, was correct as far as it went. In the Manchester commutator, numbers 27 and 28, when the commutator was complete, it could be described as a cylindrical commutator with an insulating hub. He could not say as to the segments, as they were not then attached. The hub was not attached in the same way as the segments, and sub-segments were attached to the Brush hub.

It is only one of the segments that is attached at all to the insulating body in the Manchester machine; the other segment runs upon the shaft and is in direct electrical communication with it; is that not so?—I think that is the case, but it makes no difference electrically.

But is it not a different mechanical arrangement?—Yes, it is. He should prefer a machine, he continued, for electro-plating which did not give constant potential. He should prefer a plain shunt machine, which was not liable to the accident of reversal of polarity like a series shunt machine. It was a desideratum that a plating machine should keep the magnets constantly magnetised even if there was a very small connection between the electrodes in the bath, and that was secured by a shunt machine. He had not heard of a series shunt winding machine until long after Brush had published his patent in this country. He heard of it first in connection with self-regulation, which was not introduced into this country till about 1882. He had seen Brush's plain series machines before that date, but never any compound wound. He could not say when he first heard of Varley's machine. His attention was first directed to Varley's special method of winding by some articles in the electrical papers about a year ago. The description in Varley's specification on page 8 described correctly any self-exciting dynamo, including a shunt machine, a series machine, or a compound machine.

After the witness had answered several questions in elucidation of this point, Mr. JAMESON asked:—

Is it the case that the principle of Varley's patent was what he calls separating, or the development of electrical and magnetic force and storing up magnetism in revolving coils of the armatures; does that set forth the principle of Varley's machine?—It sets forth a feature of Varley's machine. Witness understood that Varley's first claim referred to a feature of his machine which was common to the Brush, namely the cutting out of each coil of the armature when passing the neutral point.

But is the object of cutting out that coil not only to take it out of circuit, but principally to let it acquire a high degree of magnetic potential?—That is one object, and Haddan in his specification appears to have overlooked it.

After several questions on a similar line, Lord TRAYNER asked

Is there any manifest absurdity in the light of electrical science, in the first three lines of page 7 of Varley's specification?—On the contrary, they show that Varley's knowledge of the subject was very much in advance of his time.

In answer to Mr. MURRAY, witness said that the model, No. 49, shown to him, was the model of a series shunt machine.

In the present state of knowledge would it be easy to give a description of what is necessary to be done in order to secure constant potential in a series shunt machine?—It would not be difficult to give such directions.

Do you find any such directions in Brush's specification?—Not a hint of it.

JOHN WALKER, the next witness, said he was a foreman model maker in the Museum of Science and Art in Edinburgh. Mr. Brown called on him, gave him a copy of Varley's specification, and asked him to make a model from it. He did so, and the model, number 49 produced, was the one he made. Nobody helped him with it.

Mr. BROWN, partner of the pursuers' firm, said he did not attend personally to the electrical department of the firm's business. He had heard what the witnesses had said as to the models, and their evidence was correct. In his premises they had an electro-plating bath connected with a dynamo. It was used for depositing copper on hydraulic rams. He was attending to it one day, when, the engine being stopped at the time, he was told that there was something wrong with the deposition of the copper on the rams. He found it coming off instead of going on. That was in consequence of the reversal of polarity of the machine, which was a compound wound one. After that he got a plain shunt machine.

This closed the evidence for the pursuers, and the Court adjourned till Friday.

Friday, November 30th.

On Friday the proof for the defenders was commenced, counsel being as formerly. The entire day was taken up by the examination of one witness.

Prof. SYLVANUS P. THOMPSON, Principal of the City and Guilds of London Technical College, in answer to defenders' counsel, stated that he had read the specification of Haddan, the specifications and scientific communications alleged by the pursuers to be anticipations of Haddan's patent, Wheatstone's communication to the Royal Society on 14th February, 1867, Varley's specification of 1876, and Clark's specification of 1875. He was familiar with the history and development of the dynamo machine. Having described the principles of the series and the shunt machines, he said that in November, 1879, a patent was taken out for a shunt machine by the late Sir Wm. Siemens. This method of winding was described in two papers by Sir Wm. Siemens and Alex. Siemens in 1880. In 1879 the shunt arrangement was not likely to be known to an ordinary electrical workman, and no machines to his knowledge had been constructed in that year. At the date of Haddan's specification in 1878 the well-known machines were permanent magnet machines, machines excited from a separate source, machines excited in series, and machines excited by a separate but self-contained circuit. The disadvantage of the series machine was that, supposing there were few incandescent lamps in the circuit, or only a few pieces of work in the electro-plating bath, there would be only a small current, but when the lamps or pieces of work were increased in number, then because there were more paths for the electricity there would be more current at once circulating. That would more highly magnetise the magnets of the machine, and as a consequence the electricity developed would be delivered with greater electromotive force at a greater potential.

Lord TRAYNER.—Does it all come to this: that the defect of the series was the defect of getting constant potential?—Exactly; the potential rose as the current increased.

Examination resumed.—The defect of the shunt machine was of exactly the reverse kind. When more current was drawn from the machine the potential tended to fall, and when less current was drawn the potential tended to rise. Each machine erred in the opposite direction. Shown a drawing (number 54), witness said that represented a series shunt arrangement as described by Haddan. It was a long shunt arrangement, and another figure (number 55) showed another series shunt arrangement described by Haddan—the short shunt. These were merely modifications of one another. The effect of the series shunt arrangement described by Haddan, as contrasted with the mere series or shunt arrangements, was that when a larger current was drawn from the machine the potential, instead of rising as it would do with a mere series machine, would not rise so much, and it might in some cases remain steady, or even fall. On the other hand, whereas with the shunt arrangement the potential would fall when more current was drawn from the machine, in the series shunt arrangement the potential would either not fall so much, or it might remain firm, or it might even rise. The two opposite tendencies of the simple machines, in the series shunt machine tended to counteract each other and to keep the potential constant.

In whatever proportion the diameters of the wires are, and in whatever proportions the number of coils of the two wires are, is the joint effect of two wires that each wire to a greater or less extent supplements the other?—The effect of each wire is to supplement the other in every case.

And each wire to a greater or less extent prevents the disadvantages of the other from being felt?—Undoubtedly. They do not always accurately compensate, but they tend to compensate

one another. That tendency to compensate was a most valuable step in advance.

Had anything of the kind to your knowledge been disclosed or suggested prior to Haddan's patent?—Not by means of double winding. Automatic arrangements of this kind were at that date entirely new. Haddan's specification described the series shunt arrangement accurately, and the drawings attached were such as would unquestionably enable any workman who followed them to make the machine. Witness had no recollection of any passage in Haddan's description in which Haddan professed that his machine should produce constant potential. Brush's intention, he thought, was to get first the permanent minimum of magnetism, and next such an accession of magnetism as was required for the work. Haddan's machine, as a matter of fact, did produce constant potential. Witness had tried it. He had tried a machine from Brush's specification and drawings, and found that it approximated in its potential to constancy. It was driven at 1,250 revolutions per minute, the ordinary rate, and the current that was drawn from it varied from nothing up to 211 ampères. When there was no current drawn from the machine the potential at the terminals was 3·54 volts; when 100 ampères were being drawn it had risen to 3·68 volts; at 125 ampères it had fallen back to the original 3·54 volts; when 150 ampères were drawn it fell to 3·54 volts, and it remained at that with the highest current drawn, 211 ampères. He had examined several machines made according to Brush's specification. Series shunt machines were now very extensively used, but they had not superseded all other dynamo machines. Subsequent experience had added this, that a maker could now calculate beforehand the proper amount, thickness, and so forth of the two windings.

Supposing a specification to refer to dynamo machines generally, would it be possible to give in your description proportions that would materially aid the workman in determining the proportions of each particular machine?—I am afraid such instructions would mislead the workman, because he would think there was some fixed proportion. It would be far better to give him instructions how to make experiments for the proportions of each type of machine.

In the most recent machines, has the workman to determine for himself, with respect to each machine, what the precise proportions of the wires, and so on, should be, by experiment?—No, not in any established type; in any new type that would be so.

In your opinion, would Brush have given better directions for proportions than he has done?—At that date I think not, because he was ahead of all of us who were working at the theory of the subject. Brush's description left witness in no doubt whatever that he supplied his coils by a bifurcated current. That was described and shown on page 12. That excluded the notion of currents having separate origins. There was no part of the machine told off to produce a separate current. Brush referred in his specification to the use of his series shunt machine for electro-plating, among other purposes. Before his time, so far as witness was aware, none but magneto machines and series machines, and possibly machines separately excited from a separate source, had been used for such a purpose. For electro-plating, Brush's series shunt machine was a great improvement on those previous machines. The same machine could be arranged to do either a small or a large quantity of work, and another advantage was that it was less liable to reverse if the speed dropped than the series machine. He thought incandescent lighting would have been practically successful without the invention of the series shunt machine. It would have been as successful, but in a different way, by some different automatic way of making the potential remain constant. But at the time of this patent he thought there was no means of accomplishing incandescent lighting nearly so effectual as this series shunt arrangement. Any modes of accomplishing the same object equally well had been matter of subsequent invention. With regard to Varley's specification of 1876, he had been referred to page 8, where Haddan's invention was said to have been anticipated. That passage was not made the subject of any claim. A machine might be made under claim 1, that had nothing whatever to do with that passage. He had carefully read the description of the machine, but he did not understand the claim to be for the machine at all, but for a principle for cutting out bobbins. He had considered the description with the specification of the arrangements, in the course of which the passage relied on was introduced.

Are the arrangements thus described practicable arrangements, or arrangements which involve electrical absurdities?—There are several electrical absurdities in the course of the description. Witness proceeded to quote a number of statements in the description and to show how they were absurd, and was then asked—

It has been said that any absurdities which may be found in Varley are also to be found in Brush's specification; do you agree with that?—Certainly not; I have not met with any electrical absurdities in Brush's specification. Taking the passage on page 8—"Part of the electricity developed by the machine is diverted to maintain the magnetism of the soft iron magnets, and the remaining portion is used to produce the electric light," that passage was not consistent with a series shunt arrangement. It was consistent with the use of a shunt, because in shunts part of the electricity developed by the machine was diverted to maintain the magnetism of the magnets; but it was inconsistent with a series winding, because the remaining portion did not go round the magnets and produce the electric light. The essential characteristics of series shunt winding were that the whole of the electricity produced should travel round the magnets, part through one coil, part through the other, so that the whole of the electricity tended to produce magnetism of the magnets. The ways that were well known in 1879 of diverting a part of the electricity to the magnets were three varieties of the excitation by a separate self-contained circuit. These were the methods of Wilde, Rhumkorf, and Ladd. Any workman at that time would not have thought of any other way, and he would have thought of Wilde's, because it was best known at that time. Varley, in his 1867 patent, had described a somewhat similar mode, in which the two currents came from separate sources. There was no bifurcation any more than in the three machines just mentioned.

In short, the principle of bifurcation was not in 1876 a thing known to any electrical workman?—I don't think the electrical workman would ever have heard of it. The principle of bifurcation is an essential feature of Haddan's arrangement, because every shunt winding is a bifurcation upon something else. Dealing with the following paragraph of Varley's—"When the electric light is being produced, the greater portion of electricity passes through the circuit of less resistance, which I term the electric light circuit, maintaining the magnetism of the magnets, and producing the light. When the electric light circuit is opened, the electricity developed passes through the circuit of greater resistance only, and maintains the magnetism of the magnets," witness said that in 1876 that passage would not have conveyed to any ordinary electrical workman the suggestion of series shunt winding described by Brush. He thought it would have led the workman to suppose that the two windings were to be supplied from two separate groups or portions of groups of coils on the armature, and that they worked alternately. The whole description was consistent with the circuit of greater resistance being a circuit complete in itself, and separate from the electric light circuit; in other words, consistent with the then usual manner. There was no direction or suggestion whatever in that passage that the division was to be affected by the bifurcation of the original common current.

Taking a workman of ordinary electrical skill at that date, will you summarise the reasons which would make it more natural for one to understand the reference to be to a separate circuit and not to bifurcation?—He would have before him the example of Wilde's machine, where there is a separate circuit incidental to the machine for exciting, and then he would naturally look to the reference given at the beginning of the specification to the earlier machine of Varley, and would see there were two separate circuits, each worked alternately. As the drawings do not show any second circuit of any kind, he would get no information from the drawings to enable him to determine whether it was separate circuit or whether it was bifurcation. I cannot see how they could aid him at that point.

If the patentee had regarded the improvement in question as a new improvemeut would you have expected that the drawings should have included it?—Undoubtedly. Supposing the workman to pass to the general description of Varley's machine, I think he might get this light from it, that Varley describes various groups or sets of bobbins, and the workman would instinctively think that these had something to do with the separate circuits. Accordingly what he got would be light in a direction adverse to series shunt winding; and more than that, it would be light leading him towards an arrangement like Wilde's; he would only take a group of bobbins for one purpose. I don't know of anything in Varley's description of his improvement which points to bifurcation. After touching on one or two minor points, witness further stated that being asked the general question altogether, taking the specification as a whole, or confining himself to any part of it, his opinion was that it did not disclose the series shunt machine as described by Brush. It was not fitted, in his opinion, to suggest to a skilled workman having the knowledge of the period such an arrangement as that of Haddan.

If a workman of the present day, accustomed to the machines now in use, were to read the patent, what meaning would it convey to him?—I think he would read it differently, bearing in mind that shunt machines are among the commonest, and compound machines too, and that separate internal circuit excitement has largely gone out of fashion, and is almost unknown for seven or eight years back. Witness further said that the invention of shunt and series-shunt machines caused it to be laid aside and forgotten. In Haddan's arrangement the shunt actually formed a closed circuit within the machine. Varley's circuit, of greater resistance, did not form a closed circuit within the machine, but was taken outside the machine to work the motor of the lamp. It therefore could not serve the same purpose as Haddan's circuit of greater resistance. It could not be described as a circuit always closed unless the motor were constructed with great mechanical excellence. Assuming that the passage on page 8 required series-shunt winding, all Varley said was that the resistance of the shunt coil was to be high as compared with that of the series coil, whereas it must be very much higher. Unless there was a very great difference the machine would simply waste its currents in heating the shunt. Brush made a special warning against such waste. He calculated from Brush's drawings that the resistance in thin wire should be 250 times as great as that in the thick wire.

Is there anything in Varley's specification or drawings giving similar information?—Varley never shows two circuits at all, so you cannot judge anything about it. I do not know of any passage in Varley to warn the workman against making the coil of high resistance of nearly equal resistance to the other. If it were merely made higher, and not greatly higher, the machine would destroy itself. The witness proceeded to answer questions in regard to Cromwell Varley's communication to the Royal

Society, and said that the description of a secondary wire or a copper cylinder therein did not suggest to him any resemblance to the series-shunt arrangement. It had nothing to do with the mixed series-shunt winding, and it was to be placed on the magnet, and it acted in a wholly different way, namely, merely as a damper. It damped fluctuations of the magnetism, and it could do nothing more. Both it and the series-shunt arrangement were inconsistent with the language relied upon on page 8. He had examined the machine, number 29, said to have been manufactured by Siebe & Gorman. There was nothing in that machine, as it stood, to show how it was coupled up when it was used.

Is there anything in the appearances which it presents which suggests to you what the object of the machine was?—Yes, there are an unnecessary number of terminal screws to receive the ends of the wires, and that would indicate beyond all question, to my mind, that it was intended to try coupling up this machine in various ways. Experimental machines always have a variety of terminals; I have had them made myself, and I have seen the same thing again and again. On this machine there six terminals on each side of the end of the machine, and four about the middle on one side. In a machine intended for work, as a habitual rule there are only two. The wires are here left in such a state that they could be coupled up in any way.

Could the machine, as you see it, be used as a shunt and series machine, or double shunt or double series?—It could be used in any of these three ways or more.

Witness, in answer to further queries, said it could be used in every other way he had described, except permanent magnets. In the main it appeared to be a machine made according to Varley's drawings. There was nothing that he could discover by examination of the machine which would enable him to say how it was used. He did not know of any reason why the machine, if it had been other than an experimental machine, should have been coupled up as it now stood. It was usual to leave machines coupled up as they were intended to be used. He did not think the use of a single arc lamp would enable anyone to determine whether a machine was series-wound or not.

Could you, by merely looking at the performance of an arc lamp, determine whether the machine was self-regulating or not?—Scarcely. Regarding Haddan's specification of and claims for for the commutators, there was nothing in these claims which appeared to him to go beyond the fair carrying-out of the arrangement described in the provisional specification. They referred mainly to making the commutators of easier construction and of more ready repair after wear; but there was one that did not touch on either of these, where the claim was for the small detail of the insertion of metallic insulating segments.

But that metallic insulating segment was part of the wearing segment, was it not?—Yes.

And the effect of it was to cover up what would otherwise have been a blank in the surface of the commutator?—Yes.

In that way those insulating metallic segments tend to preserve the cylindricity of the wearing segments?—Undoubtedly. Witness, continuing, said he had examined the various commutators which were alleged to anticipate Haddan's claims. Number 27 had no insulating hub and the wearing surfaces were attached to the sub-segments, so that they could not be got at without dismounting the thing from the machine. The screw used did not at all resemble the peculiar screw claimed by Haddan. In number 39 there was no insulating hub and the screw was an ordinary one with a counter-sunk head. These screws would become loose as soon as their heads were worn down. In the Brush commutator the wearing segment might be worn nearly through before the peculiar form of screw there used would lose its head. Number 34 was an imperfect commutator of the same character as number 28. He had examined the commutator on Varley's machine (number 29) and he could not see that it anticipated Haddan's commutator.

Does any difference specially strike you?—The wearing segments do not seem to be detachably fastened, and there are specific differences in the arrangement of the parts that make it perform a somewhat different electrical function.

We have been told that shunt series winding was essential to the working of a particular lamp described in Varley's specification, is that so?—It is simple nonsense.

Could that lamp be worked with a shunt machine—one in which the magnets were excited by separate circuit?—Yes, with good machines, or it could be worked from any machine giving approximately constant potential. There is no foundation for such a suggestion in my view. Regarding the arrangement suggested by Cromwell Varley in his paper, witness said that the electricity came in ordinary form from the dynamo, and then that electricity was supplemented by electricity from the simple winding of the wire or copper cylinder round the magnets when they were being excited upon the series system, with the particular arrangement Varley was then suggesting. His imperfect old machine, though working in series, gave an intermittent current.

Are all Brush's claims, as you read them, claims for mechanical details?—I would put it in a different way; they are claims for useful mechanical details and combinations of details.

Cross-examined.—As regards the communication which Siemens made, in 1880, was that a communication which evidently treated shunt winding as a thing that had been already discovered, and had for its object to help people to discover the proportions of the resistance in the coils of the two circuits which would tend to give constant potential?—His whole research was towards steadying the dynamo-electric current.

But was it not a communication that frankly treated shunt winding as already found out, and proceeded to try and discover an improvement on shunt winding, which consisted in regulating the resistance of the two circuits?—I do not think so.

Can you say that it was a paper which professed to disclose a method of shunt winding?—No, he proposed to make it practical.

And therefore the discovery there, if it is a discovery, was not the discovery of shunt winding, but of certain adaptations upon the circuits which made shunt-wound machines more practically efficient for a certain purpose than they had been before?—Yes; it investigated the utility of shunt winding.

Treating it as a known thing?—As an old thing. Witness was then shown Clark's specification, page 4, and said it was a disclosure of pure shunt, and at a date previous to Brush. Not only so, but it contained a hint that pure shunt would be very useful in electro-metallurgy. It was the case that in Brush's patent, as originally framed, he claimed pure shunt, but the claim was afterwards disclaimed. Witness imagined that Varley would know of the existence of shunt at the date of his patent. Being shown number 40, witness said that, so far as that drawing went, it indicated a series-shunt arrangement. Brush never said that one of his objects was to give a constant potential. One of his objects was to secure a permanent field, and another to enable his machine to do either a large or a small amount of work.

Is that, in other words, securing a permanent minimum of power in the machine?—That is an inference, but the inference I draw is that the presence of the permanent minimum would enable him to do a larger or smaller amount of work.

In getting the permanent minimum, has he not in view that he gets it equally, whether he arranges his machine in pure shunt or in series-shunt?—Yes; his shunt part of the machine gives him a minimum in either case. In a system of pure shunt with a well-constructed machine, you get a tendency to maintain constant potential. That tendency, therefore, is not one of the features that exclusively appertains to a series-shunt machine.

Is it not the case that the success as to constant potential depends rather upon the conditions of the individual machine than upon the question whether it is series-shunt wound or shunt-wound?—That may be so.

Lord TRAYNER: But is it so?—It is so, I think.

He would have expected much more specific instructions than were given in Brush's specification if the patent had been one for constant potential. Further application of compound winding to obtain constant potential was patentable after Brush's patent. The machine of the trial of which he had spoken was on old one. Taking a machine simply constructed under Haddan's specification, it would certainly be possible to get a machine on which constant potential would not be secured unless the revolutions were very high or very low. It was a matter of opinion whether pure shunt was better for electro-plating than series-shunt. With series-shunt it was possible that the polarity of the magnets might become reversed, but not probable. With pure shunt it was not impossible where the machine had been connected to the circuit before the engine had been set in motion.

But, having started the machine in the proper direction for electro-plating—stop the machine, if you like, but allow the bath to continue to act—is it not the fact that the reversal of polarity in the series-shunt machine is a possibility, and with a pure shunt machine it is impossible?—With pure shunt I think it would be impossible. In 1878 witness did not know of any case where the incandescent light was a proved success. A perfectly suitable lamp was the difficulty, and that was discovered by degrees in 1878 and 1879, and it was introduced commercially in 1881. As soon as it did come in it was most desirable to have a constant potential. A great many methods were tried to obtain that, and the Brush Company in England worked away at the subject. Most of the devices were prior to the discovery of those conditions of proportionate resistance now known, and which ensured constant potential in a series-shunt machine. It would be quite useless to have an extraneous device when it could be secured in the machine itself by simply wrapping the wires in the proper way.

This concluded the procedings for the day, and the further hearing was adjourned till Wednesday, the 5th inst.

(To be continued.)

The Telephone in East Kent.—The South of England Telephone Company is making rapid strides with the construction of trunk lines in East Kent. The Canterbury line, which takes 26 miles of wire between that city and Dover, was opened a few weeks ago and has been greatly appreciated by the subscribers, and the company will, in the course of a few days, open up another trunk line between Ramsgate and Canterbury which will be connected with the whole system. In addition to this the Canterbury-Faversham line is in course of construction. What the subscribers, however, are most anxious about is that connection should be obtained with London and the company promises that this will eventually be done. Mr. Burden, the district manager, is very energetic in pushing forward the work of the company.

INCANDESCENT LAMP PATENTS.

EDISON & SWAN UNITED ELECTRIC LIGHT COMPANY v. HOLLAND.
(Before Lords Justices COTTON, LINDLEY and BOWEN.)

THE hearing of the appeal of the plaintiffs in this case from the decision of Mr. Justice Kay commenced on Saturday last, when the Attorney-General, Mr. Aston, Q.C., Mr. Moulton, Q.C., and Mr. Bremner, instructed by Messrs. Ashurst, Morris, Crisp & Co., appeared for the appellants, and Sir Horace Davey, Q.C., Mr. Finlay, Q.C., and Mr. J. C. Graham, instructed by Messrs. Renshaws, for the defendants.

The ATTORNEY-GENERAL said the action related to infringement of letters patent now vested in the Edison and Swan United Electric Light Company for an incandescent lamp, the same patent as was before their lordships in the case of Edison *v.* Woodhouse & Rawson. There were two patents concerned in the action, the Edison and the Cheesbrough. The Edison patent related to the mode of construction of an incandescent electric lamp, the Cheesbrough patent related to a method of preparing in a better way the conductor to be used in an incandescent electric lamp, that was to say, the carbon. Mr. Justice Kay found for the plaintiffs in respect of the Cheesbrough patent; he found a number of issues for the plaintiffs in the Edison patent, but he found one matter against them, namely, the sufficiency of the specification. There was no appeal against the decision in regard to the Cheesbrough patent. This appeal was by the plaintiffs against that part of the judgment which found for the defendants on the ground of the objections that were taken to the Edison patent. He proposed to state to their lordships, as fairly as he could, what was the existing state of knowledge at the date of the patent. Having done that he proposed to call to their attention the specification of Mr. Edison, to see what his invention was on the face of that document. Then he should at once take the judgment of Mr. Justice Kay and show to their lordships, if he could, the errors into which the plaintiffs alleged he had fallen, and should afterwards bring up so much of the evidence as had a direct bearing on the issues. One observation which he wished to make with reference to the case lay upon the threshold of his attack upon Mr. Justice Kay's judgment. The experiments upon which the sufficiency of the specification were attacked were substantially—he might almost say without exception—made after the trial of the action had actually commenced. With reference to the allegation as to the sufficiency of the specification, he should be able to demonstrate that this evidence was a complete afterthought, and that the experiments upon which the main attack was made were made after the principal witness for the plaintiff had been examined. The experiments having been made by Mr. Crookes, developed into an attack upon three or four specific points. The plaintiff, of course, called rebutting evidence. In consequence of that rebutting evidence, which was of the most remarkable character, Mr. Justice Kay said he would have the experiments repeated before an independent referee. Prof. Stokes, of the University of Cambridge, was chosen as the independent referee, and he made a report to the court that on every one of the matters of attack which the witnesses had brought against the specification they were absolutely and entirely wrong; and that, except in the most minor matters, there was not the slightest foundation for the specific attacks that had been brought. He thought he should be able to satisfy their lordships that there was, possibly owing to the length of the case, forgetfulness in the mind of Mr. Justice Kay as to certain most remarkable things which had been proved. [The Attorney-General continued his argument upon the lines he had indicated throughout the sittings of Saturday and Monday, and was followed during Tuesday by Mr. Fletcher Moulton on the same side. The case was adjourned over Wednesday, and was to have been resumed after the hearing of another case on Thursday.]

NOTES.

Electric Light at Buckingham Palace.—We hear that the hall at Buckingham Palace is to be fitted with the electric light before next season, but the Queen will not allow this improvement to be introduced into the private apartments at Windsor Castle, as was desired by Sir John Cowell, for her Majesty prefers shaded lamps and wax candles. The State apartments, the hall, and the lower end of the corridor are fitted with the electric light, but it is to go no further at present.

St. Olave's and the Electric Light.—At a meeting of the St. Olave's (Southwark) Board of Works last week, it was resolved, on the recommendation of the works committee, to oppose the proposed licence of the London Electric Supply Corporation to erect and maintain electric lines and works, and to supply electricity within the district.

Chelsea and the Electric Light.—At the last meeting of the Chelsea Vestry, the Electric Lighting Company reported that it had considered a letter from Major Waller, on behalf of the London Electric Supply Corporation, dated November 13th, requesting permission to lay an underground cable along the Pavilion Road, as shown on an accompanying plan, and the committee recommended that the application be granted subject to the terms of the Chelsea Electric Lighting Order, 1886, being embodied in an agreement between the Corporation and the Vestry, and during the pleasure of the Vestry. With reference to this recommendation, a deputation of four gentlemen representing the Chelsea Electric Supply Company was introduced by General Webber. General Webber said it had been arranged for Lord Thurlow to speak on behalf of the deputation, but his lordship had not arrived, and had probably been detained at the House. In his absence, General Webber proceeded to ask that the Vestry would not approve the recommendation of the Electric Lighting Committee set out above. He did so on the ground that such an introduction by the Vestry of competition in the supply of electric light in that part of Chelsea known as District A, for which his company had a Provisional Order, would be a serious disadvantage to them. The deputation having retired, Mr. Mossop then moved the adoption of the committee's recommendation to grant the application of the London Electric Supply Corporation for permission to lay an underground cable along Pavilion Road during the pleasure of the Vestry. He reminded the board that the Electric Lighting Act was opposed to the establishment of any monopoly. The Vestry had also to protect itself from the introduction of overhead wires. They had no power to insist on underground wires, but both the Cadogan Electric Light Company and this London Electric Light Corporation relieved them of the difficulty by volunteering to give undertakings to lay their wires beneath the pavement. The Vestry having thus got the power into its hands again should not sanction any monopoly, but only consider the interests of the ratepayers. The Chairman then put Mr. Mossop's motion to the vote, and it was carried unanimously, the deputation being informed of the decision. It was also resolved, on the recommendation of the committee, that the application of the Cadogan Electric Light Company for permission to lay a 2-inch iron pipe beneath the pavement from their works in Manor Street to the Chelsea Embankment be granted, and also that in all future cases in which the pavement is disturbed for the laying of electric wires or cables the Vestry re-lay the pavement, at the cost of the company.

Electric Lighting in Lancashire and Yorkshire.—It gives us pleasure to note that Messrs. S. Charlesworth & Co., Electrical Engineers, of Oldham, have been awarded a silver medal for the excellence of their exhibit at the Barcelona Exhibition. We understand this firm has now in hand installations for Messrs. Platt Brothers & Co., Limited, Hartford Old Works, Mr. S. R. Platt, Werneth (both being complete, with steam engines, while the last includes a boiler made by the Oldham Boiler Works Company) repeat orders for over 100 lights from the Palm Mill Company, Limited, and also two sets of patent portable plant for the night navigation of the Suez Canal for the same firm, for whom the first was made, which passed immediately and successfully the company's stringent conditions and trial run. These plants are quite complete, having a high speed vertical engine coupled direct to the dynamo on the same bed plate. The firm has also started recently a complete installation of over 400 lights for Messrs. Jos. Sykes Brothers, the well-known card manufacturers, Lindley, near Huddersfield, who are well pleased with the substitution of the light for gas.

Lighting Ferry Boats.—The Metropolitan Board of Works has decided to name the two new steam ferry boats at Woolwich the *Duncan* and the *Gordon*, and has also determined that they shall be lit by electricity.

The City and Electric Lighting.—At a meeting of the Court of Common Council last week, Mr. W. H. Pannell, chairman of the City Commission of Sewers, stated, in reply to Mr. J. V. Moore, that the Commission had taken the advice of Mr. W. H. Preece, F.R.S., the electrician to the Post Office, and Colonel Haywood, their engineer, and they had virtually agreed on the lines on which tenders for the electric lighting of the City should be invited. Every substantial electric lighting company would be asked to tender, and it was hoped that before long the City would be lighted in that way.

At a meeting of the City Commissioners of Sewers on Wednesday, notices of the House-to-House Electric Supply Company and the London Electric Supply Company, of their intention to apply for Provisional Orders to supply electricity for lighting and other purposes in the City, were referred to the Finance and Improvement Committee to consider.

Extremely Unsatisfactory.—We read in the special *Evening Standard* of December 5th :—"Telegraphic communication with Australia is reported to be temporarily interrupted, owing to an accident to the landlines." It would be interesting to know, supposing the above report should prove to be correct, on what portion of the extensive landline system, upon which we depend for communication with our Colonies, the "accident" referred to has occurred. Was it in Europe, on the Isthmus of Suez, in India, in Java, or in Australia, regions which contribute each its quota of landlines, that the interruption has taken place? It is to be hoped that the rumour may prove to be false, or, at all events, that the line may be speedily repaired, for this would make the fourth occasion since the commencement of July upon which telegraphic communication between Great Britain and her Australasian Colonies has been interrupted. (As we go to press we are informed that the Eastern Telegraph Company has contradicted the statement of the *Standard*.)

Declined With Thanks.—We have received a block purporting to be representative of the premises of a well known electrical firm, with the request that we should insert it in our present issue. We fail to see the utility of taking up a large portion of our space with a picture which cannot possibly interest our readers, especially as the descriptive matter frankly states that the beautiful frontage is not occupied by the firm in question whose works are at the back. Furthermore, it matters little to the electrical fraternity at large how the employès of this firm spend the dinner hour, and we must be pardoned if we decline to use our columns for a purpose which is really best suited to an advertisement.

A Big Order.—The Woodhouse & Rawson Electric Manufacturing Company, Limited, has recently received an order for over 100,000 switches which is believed to be the largest ever given.

Electric Lighting Provisional Orders.—Last Friday evening, in accordance with the provisions of the standing orders, plans in relation to schemes of Private Bill legislation which it is intended to promote in the next session of Parliament, were deposited at the Private Bill office of the House of Commons. The following is a list of the electric lighting provisional orders :—Kensington and Knightsbridge Electric Lighting Company, Metropolitan Electric Supply Company, North London ; Metropolitan Electric Supply Company, West London ; Metropolitan Electric Supply Company, South London ; Metropolitan Electric Supply Company, Mid-London ; Notting Hill Electric Light Company, Westminster Electric Supply Corporation, London Electric Supply Corporation.

Electric Light at the Italian Exhibition.—This installation, which consisted of over 300 arc lights, and between 300 and 400 glow lamps, was run, we learn, without a single interruption which could be charged to the dynamos. The service was only partially interrupted on two occasions, once when the main belt of one of the engines broke, and again when a belt on one of the dynamos parted.

Electric Lighting Tenders.—Tenders are invited for supplying some large stores at Bracknell (Berks), with electric light. For further information apply to Messrs. Thos. Lawrence and Sons, The Stores, Bracknell, Berks.

Mill Lighting.—At the quarterly meeting of the Rochdale Co-operative Spinning and Manufacturing Company less than two months ago the shareholders were asked to sanction a scheme of electric lighting which the directors had approved. That permission was given, and the work was at once put in hand. The directors decided to adopt Edison-Swan lamps, and in all 130 of these have been erected. The offices, board room and lodge have been fitted with them entirely. For the most part 16-candle lamps have been adopted, but in the offices four 32-candle lamps have been placed. The remainder are distributed in various parts of the mills. The boiler house, the room over the boiler house, the engine house (partly), and several dark passages have been fitted with them. In addition one lamp has been placed in each room, and an adequate number in each landing and staircase. The advantage of this is that immediately the engines stop the gas-lights are turned out, and the electric lamps provide light sufficient for the purpose of exit. Current is produced by one of Mather and Platt's dynamos. This is situated in a little room at the end of the engine house, and is driven from either the ponderous beam engines which turn the main portion of the machinery or from a small engine which is used for a small section. Electric lighting has been adopted mainly on the ground of economy. The initial outlay has been about £400, and the gas bill, it is expected, will be reduced by £200 a year.

Lighting of Works.—Nobel's explosive works at Ardeer Stevenston are to be electrically lighted.

Ship Lighting.—Last Saturday the Fairfield Shipbuilding and Engineering Company, Limited, launched from their yard the steel screw steamer *Dresden*, of about 4,500 tons, for the Norddeutscher Lloyd of Bremen. The vessel will be fitted with all the most modern improvements, and lighted throughout by electricity, for which purpose she has two distinct engines and duplicate dynamos, each furnishing power for about 300 incandescent lamps. The new steamer *Lady Martin*, recently launched from the shipbuilding yard of Messrs. Workman, Clark & Co., of Belfast, and built for the British and Irish Steam Packet Company, Dublin, was tried for speed on Thursday week between the Clock and Cumbrae lights with satisfactory results. The vessel is fitted throughout with the electric light, and the saloon and state-rooms are sumptuously upholstered.

The Lighting of the new Theatre at Exeter.—It is hoped that in the course of a few weeks the Electric Light Company will be in full work in the City of Exeter, in which event negotiations will probably be opened without delay with the view of lighting the new theatre by means of electricity. A suggestion that such should be done in the interests of public safety was made by the Borough Surveyor, who considered electric lighting a *sine qua non*. The matter was mentioned by the Mayor at the last meeting of the Town Council, when a hope was expressed that all would co-operate together with the view of securing a building which would be a credit and advantage to the city.

The Electric Light at Bradford.—The *Yorkshire Post* states that considerable progress has been made during the last few weeks, accidents and disappointments notwithstanding, with the experimental installation of the electric light which the Corporation of Bradford has decided to carry out. The erection of the depot in Bolton Road, not far from the Midland Railway Station, is being proceeded with as quickly as weather and other circumstances will permit. Workmen have also been employed for some days back in laying the cables along Kirkgate and some of the other thoroughfares in the centre of the town, and it is believed that the whole of the preparations will be completed before Christmas. A sum of £15,000 has been granted by the Town Council to the Gas Supply Committee to cover the cost of the installation and incidental expenses connected with it. Should, however, the experiment be successful, and the tradesmen and others in the centre of the town show a disposition to avail themselves of the facilities offered them by the Corporation for lighting their premises by electricity it is probable that the area of supply will be extended. The number of applications which the committee have already received lead them to expect that such an extension will soon become necessary, and foreseeing this contingency, they are carrying out the present works as though they were but a part of a larger scheme, which the Provisional Order obtained for the purpose authorises them to effect. Two main cables are being laid under the roadways from the depot along Market Street to the Town Hall, and up Darley Street as far as the Free Library. It is anticipated that both these public buildings will be lighted by electricity, which will also be supplied to tradesmen and others along the streets through which the cables pass. Connecting wires can, with little difficulty and at a moderate cost, be laid under adjacent streets, so that, if need be, the whole of the centre of the business part of Bradford can be lighted by means of electricity during the course of a few months from the present time. The experiment is being watched with considerable interest by neighbouring municipalities, and should it prove successful others may be led to follow the example set them by Bradford.

The Electro-Harmonic Society.—The Amateur (ladies') night of this Society, with genial Mr. Spagnoletti in the chair, was held on Friday evening last, and appeared to give the members and friends who assembled in large numbers, great gratification. It is rarely, indeed, that a concert which is dependent upon amateurs throughout is without some little weaknesses, but we think that but little fault could be found with those ladies and gentlemen who so kindly combined together to show what a vast amount of real musical culture exists within the Electro-Harmonic Society. Seldom, indeed, do we find such a vocal trio as Mrs. Alex. Siemens, Mrs. Theobald, and Miss Mary Doughty, excepting in professional circles, and the same may almost be said of their male associates. A pleasing feature in the programme was the violin playing of Miss Edith Doughty, a young lady in her 15th year, whose perfect intonation and expression lead us to the belief that she will, with perseverance become an exceptionally fine performer. With Mr. Stepney Rawson as the exponent of the "cello," with Mrs. Elvin, Miss Rawson, Miss Margaret Doughty, Mr. Siemens, and Izard presiding at the piano, and the Rev. G. B. Doughty as elocutionist, a most enjoyable evening was spent. A special word of praise should be accorded to Mr. Reginald Jones for filling the place of Mr. Thos. Harrison at a day's notice.

Telephonic Extension in Newcastle.—The Northern District Telephone Company has just opened a new branch at Jesmond, by which communication may be made with all the company's system, both to subscribers and to the general public. The latter will be able to transmit messages to places in Newcastle and Gateshead for 1d., and to other towns for 6d. each. The company also proposes to establish a Jarrow exchange.

Telephone in Kent.—The South of England Telephone Company has just completed the trunk line connecting Ramsgate with Canterbury. The towns of Margate, Ramsgate, Canterbury, Dover and Folkestone, are now in telephonic connection, and it is contemplated to extend the trunk lines to Faversham, Ashford and Whitstable.

The Recent Maxim-Weston Meeting. — Messrs. Michael Abrahams, Sons & Co., solicitors to Mr. Hugh Watt, M.P., have intimated that they have been instructed to commence an action for slander against Mr. John Marks, chairman of the recent meeting of the Maxim-Weston Electric Company, "in respect of the unfounded and unjustifiable statements made by him" relative to Mr. Watt.

New Atlantic Cables —The *Standard* correspondent at Ottawa telegraphed on Wednesday night that a company of Anglo-Canadian capitalists is being formed to lay a cable from the Straits of Belleisle to Scotland. By way of subsidy, the Dominion is expected to contribute the land for the lines from the St. Lawrence to the Straits. The tender of the Telegraph Construction and Maintenance Company, of London, to lay cables from Halifax to Sable Island for a subsidy of ten thousand dollars for ten years, is favourably reported upon.

International Cable Convention.—According to the *Reichsanzeiger*, a Berlin newspaper, the British Government has announced the accession of various British Colonies and Possessions, including Canada, Newfoundland, the Cape, Natal, New South Wales, Tasmania, Western Australia, and New Zealand to the International Convention for the protection of Submarine Cables. The Convention was originally agreed to on March 14th, 1884.

English and French Telegraphic Communications.—An interesting report has just been made by the *bureau* of the International Service of Posts and Telegraphs. The importance of the relations between France and England may be estimated when we state that Paris and London are the two cities of the world between which the telegraphic communications are most considerable. While the greatest number of wires from Paris to any other place is six (from Paris to Marseilles), between Paris and London there are twelve telegraphic wires.

Electrical Transmission of Power. — Considerable attention is being paid in Austria to the transmission of power by electricity. The Oerlikon Company has been particularly active in this direction. At Musbrück there is at work a plant transmitting 50 H.P. to a distance of 500 yards, and many other projects are in serious consideration. Among these it is proposed to transmit 400 H.P. to a distance of 650 yards at Steyrermühl, where a 100 H.P. plant is already at work.

Akron Electric Railway.—At Akron (U.S.), the electric railway appears to have given great satisfaction, having been worked since the commencement without a hitch. The road is very hilly, yet a speed of from 12 to 13 miles an hour is maintained with ease. From an incident which recently occurred, it was proved that complete control, even when descending a steep grade, can be exercised over the car by reversing the motors. In this respect, indeed, an electric car is under greater control than one driven by any other motive power.

Society of Telegraph-Engineers and Electricians.—The annual general meeting of the Society will be held at the Institution of Civil Engineers, 25, Great George Street, Westminster, on Thursday, the 13th day of December inst., at 8 p.m., for the reception of the annual report of the council, and for the election of council and officers for the ensuing year. The discussion on the following paper read at the last ordinary general meeting will be concluded: "On a System of Electrical Distribution," by Henry Edmunds, Member

More Fires in the Calumet and Hecla.—The Calumet and Hecla copper mine at Marquette, Michigan, was set on fire last Thursday. Two hundred men were in the mine when the fire first broke out, and all escaped but eight, who were suffocated. The survivors report that the signal wires of the water conduits were cut, so that it was impossible to check the fire or send signals, and bitter denunciations are heard of the incendiary. The Hecla stock has declined in Boston from 305 to 255, closing at 265. This is the richest mine controlled by the French copper trust, and it has evidently been fired in order to influence the markets.

Effects of Static Electricity and Lightning on the Body.—Dr. Rojdestvenski, of St. Petersburg, who has been carrying out a series of observations on the effects of static electricity on animals, finds that the death is, usually at least, due to the action on the cardiac muscle. In cases of death from lightning it is by no means always possible to demonstrate the existence of morbid changes in the nervous tissues. During the experiments with static electricity it was found that the greatest effects were produced when the animal was insulated. As to the electrolytic, or chemical effects, Dr. Rojdestvenski regards them as having little, if any, relation to the fatal results.—*Lancet.*

The Woodward Battery.—Mr. E. J. Mason, formerly of the E.P.S. Company, of London, has lately finished erecting a storage battery on the Woodward system at the sanitorium, Battle Creek, Michigan, U.S.A.

Writing on Roses.—A pretty fancy at a recent lunch given by an American lady renowned for her taste and originality was that of marking the places of her guests by a single perfect rose, upon a petal of which was delicately inscribed the name of the person to occupy the place. The writing is done by means of electricity, the effect of the electrical current being to take the colour out of the leaf, leaving a white line.

Electric Cars in Australia.—The Sandhurst-Eaglehawk Tramway Company, Melbourne, has ordered, to the designs of Mr. Reckenzaun, storage cars for its road. The speed is to be 5 miles an hour up gradients of 1 in 20, and on the level 8 miles an hour. The cars are provided with two 8 H.P. (nominal) motors, worked from a battery of 72 storage cells.

American Electric Railways.—The great snowstorm of November 9th, which visited St. Joseph, Mo., paralysing business, blocking railways, breaking down electric lighting, telegraph, and telephone lines, did not interfere with the working of the Union Passenger Railway line (electric) in that city. None of the overhead conductors were broken down, nor did any of the motors fail. The line was built by the Sprague Company, and reflects great credit on the manner in which they executed the work. The Sprague system seems to have turned out a commercial success on the East Harrisburg Street Railway. On this line a net profit was made in the month of September of £480, being at the rate of 30 per cent. on the capital outlay.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Barnet and District Electric Supply Company, Limited.—The statutory return of this company made up to the 22nd ult. was filed on the 3rd inst. The nominal capital is £5,000 divided into 490 shares of £10 each and 100 shares of £1 each. 70 of the £10 shares have been taken up and £5 per share has been called thereon. The calls paid amount to £250 and unpaid to £100. Registered office, 31, Wilson Street, Finsbury.

Chelsea Electricity Supply Company, Limited.—An agreement of 6th ult. filed on the 1st inst., between this company and the Anglo-American Brush Electric Light Corporation, Limited, states that by an agreement of the 9th July, it was agreed that the Brush Company should supply this company with certain plant, &c., in consideration of £6,488 payable as follows:—25 per cent. when the order to proceed with the works was given, 50 per cent. on monthly certificates of the work done by them, and the balance together with certain founders' shares within four months of the due completion of the work therein mentioned. By an agreement of 26th July, the Brush Company undertook to accept payment of all or any part of the contract price in fully paid up ordinary shares of the company. On the 26th September an order was given by the Chelsea Company to the Brush Company to proceed with work of an approximate value of £4,000, and the Chelsea Company has exercised its option to pay 25 per cent. thereof, or the sum of £1,000, in shares, reserving the right to pay all or any further part in ordinary shares.

British Electric Light Company, Limited.—Upon the petition of S. S. Stott and Company, of Lancaster Foundry, Haslingden, Lancaster, the Chancery Division of the High Court of Justice ordered the winding up of this company on the 13th February, 1886, and by a further order, dated 26th September (filed 27th ult.), all further proceedings (except for carrying out this order) are to be stayed, the Court sanctioning a scheme of arrangement with the holders of the £6,000 6 per cent. debenture bonus loan issued by the company, and the creditors and shareholders of the company.

NEW COMPANY REGISTERED.

Electropathic and Turkish Baths, Limited.—Capital: £10,000 in £1 shares. Objects: To acquire the Turkish Baths, Station Approach, and Denman Street, Southwark, and two letters patent for improvements in electric baths, and for an apparatus for the administration of electricity to the human body in Turkish baths. Signatories (with 1 share each): Alexr. Kerly and Hy. Verdeu, 14, Great Winchester Street; *J. J. Evans, 5, Ave Maria Lane, E.C.; *M. Humm (electrician), 727, Commercial Road, E.; S. Sewell, 731, Commercial Road, E.; T. Gregoley, The Cottage, Limehouse; *D. Elvin, 21, Andover Road, Hammersmith. The signatories denoted by an asterisk, and G. Robinson and J. H. Godwin, are the first directors. Qualification: 100 shares. Remuneration: £50 per annum in respect of each director. Registered 3rd inst. by Kerly, Son and Verdeu, 14, Great Winchester Street.

Caddy and Company, Limited.—Capital £10,000 in £1 shares. Objects: To take over the business of mechanical engineer, carried on by Thomas Edward Caddy at Daybrook, near Nottingham, and to carry on the business of mechanical and sanitary engineers, manufacturers and dealers in apparatus and appliances used in connection with the generation, distribution, supply, accumulation, and employment of electricity, and generally to transact the business of electricians in all branches. Signatures (with one share each) *Hy. Hill, *Fredk. Hill, *T. E. Caddy, *T. E. Caddy, jun., E. H. Hill, W. H. Caddy, all of Nottingham, Thos. Hill, Louth. The signatures denoted by an asterisk are the first directors; the company in general meeting will determine remuneration. Registered 3rd inst. by R. Jordan as agent for Messrs. Wells & Hind, solicitors, Nottingham.

CITY NOTES, REPORTS, MEETINGS, &c.

Maxim-Weston Electric Company, Limited.

AN extraordinary general meeting of this company was held at the Cannon Street Hotel on Monday, Mr. John Marks, chairman of the company, presiding.

Mr. Samuel J. Boyce, the secretary, having read the notice convening the meeting,

The Chairman said that part of the business which they had met to transact that day was of a contentious character, whilst part was of a non-contentious character. With regard to the first resolution on the agenda, that the company be wound up voluntarily, and that certain gentlemen be appointed liquidators, he would ask them to be good enough to divide that into two resolutions. The first part, that relating to the winding-up, would probably be unanimously agreed to—in fact, the company must be wound up, because it could not continue. On that he thought there would be no opposition to the suggestion of the directors; but he gathered that there was likely to be some opposition to the appointment as liquidators of the gentlemen named in the resolution. A separation of the two things would, therefore, enable them to save time and discussion. They would recollect that at the last meeting, held for the confirmation of the reduction of capital, it was arranged that unless 80,000 of the unissued shares were applied for the directors would not make any allotment. That number was not applied for, in fact, there were applications only for about 25,000, and they, therefore, did not proceed to allotment, but returned the money paid on application. The result of the shareholders not coming in and taking up the minimum number of shares agreed upon was that the capital necessary for carrying on the business of the company was not provided, and consequently there was no help for it but to wind up. He therefore moved "That the Maxim-Weston Electric Company, Limited, be wound up voluntarily."

Sir Henry Hart seconded the resolution.

Mr. George Bowyer said, as one of the original shareholders of the company, he wished to know whether there was any explanation to be given of the steps to be taken in the direction of a further enquiry into the conduct of the Member of Parliament who was till lately their chairman with regard to the disposal of some of the shares. Something like £120,000 seemed to have been disposed of in a very mysterious way; there was very little account of it. True, they had had reports of what had taken place at the meetings, but those meetings had, in most cases, been only partially reported, and those who had not attended the meetings had not been able to gain any information as to what had been done. He wished, also, to know whether the accountants who had passed the very extraordinary accounts of which they had heard were to be in any way brought to book. There seemed to him to have been a very extraordinary conspiracy, and he thought some enquiry ought to be instituted.

The Chairman said those matters were at present before a court of law, and they did not feel justified in anticipating the action of the court. They had not, however, been lost sight of by the directors, and he quite agreed with Mr. Bowyer that there were matters calling for investigation, and, feeling that, the directors had commenced an action against Mr. Watt, during the progress of which the whole of those matters would be fully investigated.

The resolution was put, and carried with but one dissentient.

Mr. Hirsch moved the next resolution, which was: "That Mr. John Marks, of 113, Great Russell Street, W.C., Mr. J. M. Klenck, 42, Bishopsgate Street, Within, E.C., and Mr. Louis Swaby, of 23, Churchfield Road, Ealing, be and they are hereby appointed liquidators for the purpose of the winding up of the company." In moving the appointment, he said he need say but little, as the proposed liquidators were thoroughly well known, and he was sure they would do the best they possibly could for the interests of the company. It was a matter of some importance, in view of the legal differences with Mr. Watt, that they should be as unanimous as possible in electing the liquidators, who, as directors, had already done a great deal on their behalf, first, by staying the action instituted by Mr. Watt, and, secondly, in seeing that the claims they had against Mr. Watt were brought forward.

Sir Henry Hart said he knew nothing whatever of the affairs of the company, although he had held shares for five years. He had called two or three times at the offices, and had always been informed that they were very short of money. With regard to the proposed liquidators, he had not a single word to say against their reputation, or against their social, business or private position; he simply did not know them, and he would be glad if someone would inform him as to what the position of the company had been, what they had done for the company, and what Mr. Watt had done against it. It seemed that the name of Mr. Watt was not in good odour at that meeting. Mr. Watt had treated him with great courtesy upon the occasion of one of his visits to the office, had answered his questions, and he had nothing to say against him. But in justice to Mr. Watt, and in justice to the gentlemen who were proposed as liquidators, he would ask that it should be stated what it was that was alleged against Mr. Watt.

The Chairman said it had been his intention to make some remarks upon the next resolution with regard to the point raised by Sir Henry Hart. He did not think it bore upon the appointment of liquidators.

Mr. Hodge seconded the resolution.

Sir Henry Hart pressed for an answer to his question, as he wished before voting to know something of the real position of the company, and what the present directors had done for it.

Mr. Hirsch remarked that if Sir Henry had attended previous meetings, he would have had no need to put the question.

Mr. Ramsden: I am another shareholder who has not attended previous meetings, and I also want to know something about these gentlemen. Will the directors tell us what they have done for us. If they have done anything which has been of benefit to the company, I shall vote for them.

Mr. Newton rose, amidst cries of "Vote! vote!" and said he thought shareholders were quite justified in asking for some information as to the proposed liquidators, and he would endeavour to give it. With regard to what Mr. Watt had done for the company, he had heard him boast of having paid dividends. Those dividends led him (the speaker) to take shares in the company at £5, which he believed were not now worth 5d. He had the management of the company for some years, and when he left there were no funds in the till, and no business doing of any moment. He had spoken in his last report of a large amount of business that had been done. As one of the members of the committee of investigation, he (Mr. Newton) was in a position to say that that committee failed to find any business that was satisfactory in any shape or form. Mr. Watt took for his services—he was entitled to take £1,200 a year, but during the latter part of the year, when business was not so good, he took £1,000.

A Director: No, no. He said he only took £1,000, but he took £1,200 and commission.

Mr. Newton, continuing, said Mr. Watt told them in that building that he reduced his salary to £1,000; it was now stated that he did not reduce it. But in addition to that salary, he took a commission on business introduced by himself. He (the speaker) contended that no director was entitled to take such a commission, unless it was under a special resolution carried by the shareholders. It was a breach of trust, in his view: he might be wrong, but that was his opinion. As regards the proposed liquidators, he was convinced that it was not possible to select a better man than Mr. Marks to look after the interests of the shareholders. Referring to the circular which Mr. Hugh Watt had sent to a few of the shareholders, suggesting that a high-class professional liquidator should be appointed, Mr. Newton said there was no high-class official liquidator in the City of London who would look after the interests of the shareholders with greater zeal and more uprightness than Mr. Marks, who was a sound and good man of business. There were those in that room who had known Mr. Klenck for some years; he, himself, had the pleasure of his acquaintance, and he knew that if there was anywhere a keen man in investigating accounts, that man was Mr. Klenck, and they could not do better than give Mr. Marks the advantage of Mr. Klenck's great ability. He did not know Mr. Swaby previous to his (the speaker's) connection with this company; but those who were present at the meeting at which he set forth his views in opposition to Mr. Watt, must have admired the persistence and determination with which he spoke at that meeting, and the manner in which he withstood the attacks made upon him by Mr. Watt. They wanted some one imbued with a feeling of that kind to look after the affairs of those shareholders who put their money into the Maxim-Weston light on the faith of Mr. Watt's ability and integrity. Therefore, he failed to see how it was possible for shareholders to select three better men to look after their interests. It was necessary that they should vote with as much unanimity as possible, because opposition was intended, or the proxy papers some of them had received would not have been sent out. The judge, when he was asked to confirm the appointment of liquidators, would pay attention to the representations of a large number of shareholders. It must be borne in mind that Mr. Watt claimed in the letter he had sent out that he was a holder of nearly 8,000 shares, and that large interest would have weight with the court unless the shareholders backed up the liquidators with as unanimous a vote as possible.

Mr. Ramsden said he attended that meeting to represent a considerable number of London shareholders who had asked him to look into the accounts of the company. He had asked Mr. Watt for a copy of the accounts and for explanations of them, and he had given them, and his (the speaker's) view of the position, as a man of business, was that the claims they had made against Mr. Watt were rather wide of the mark. What had the present directors done? Nr. Newton was not a director, and was not in a position to tell them.

A Shareholder, whose name was not given, said he had never attended a meeting of the company before, but had bought his shares at a premium. He had hoped a good deal from the new directors, but the only result of their appointment was that they were going into liquidation. He, too, wanted to know what the new directors had done, and he thought he was entitled to know. His impression was that unless the shareholders could be satisfied upon that point it would be far better that the affairs of the company should be wound up by an official liquidator. He would go further than that, and state that he had himself prepared a petition to place on the file that morning, but as he was only a small shareholder he did not think it right to file it unless he was supported by a large number of shareholders.

The Chairman said he would answer the question as to what the new directors had done. Would they inform him what new directors could do coming into a concern like that, finding a balance at their banker's of £2 16s. and writs for hundreds of pounds flying about their heads? The best thing they could do was what they did. They went to the bank and asked for an overdraft of £1,000, but the bank would not allow a pennypiece on the security of the company. On the security of the individual directors they did lend them £1,000, which was expended in paying debts contracted during Mr. Watt's management. They did not pay away that money to everybody who choose to issue a writ against them, but they carefully investigated every case, and he was sorry to say that in most instances they found that the claims made were just claims against the company, and they did their best to satisfy them. The next thing they did was to appoint a firm of chartered accountants to thoroughly investigate the accounts. He was fully

aware of the gravity of what he was saying, and of the responsibility attaching to it, and he said this deliberately, that the last balance sheet issued to the shareholders was absolutely false. Mr. Watt showed a fictitious profit, upon which he took 5 per cent. commission; not only that, but the sales he entered as *bona fide* they found to be bogus; large profits shown on the books turned out to be serious losses, yet he had taken his 5 per cent. on them. It was Mr. Watt's management, or mismanagement, which had brought them to their present position. Now he (Mr. Watt) sent out a circular saying that as the holder of 8,000 shares he could not allow that company to go to ruin without making an effort to prevent it. He took credit for holding 8,000 shares, but he had to thank the directors for that. He had actually sold 6,500 of them, but as soon as the transfers came into the office they refused to recognise them: they had a lien upon the shares for the debt owing to the company from Mr. Watt. They were now suing him in the Court of Chancery for the return of £4,600, money they alleged to have been improperly extracted from the coffers of the company. He did not like to say anything in anticipation of the judge's decision, but he might say that they had every confidence as to the result.

The motion was then put and carried, with three dissentients, one a proxy of Mr. Watt's.

The Chairman said he would put the remaining resolutions together, and ask them to vote upon them. They were as follows:—

"2. That the liquidators be and they are hereby authorised to sell and transfer, subject to due provision being made for dissentient shareholders (if any), all the letters patent, business, property, machinery, plant, assets, and effects of the company, whatsoever and wheresoever, to a company to be formed with limited liability, under the Companies' Acts, 1862 and 1886, with a capital not exceeding £75,000 divided into 500,000 shares of 3s. each, for the purpose amongst other things of taking over and working the property of this company upon the following terms:—

"(*a*) The new company shall pay and discharge the debts and liabilities of this company, and also the expenses of and incident to the winding up of the same, and of the incorporation of the new company, and of the sale and transfer by the liquidators of the assets and liabilities of the company to the new company.

"(*b*) The new company shall allot and issue to the liquidators, or as they shall direct, 312,000 shares in the new company of 3s. each, upon each of which there shall be credited the sum of 2*s.*, a proper agreement being filed with the Registrar of Joint Stock Companies before the issue of such shares, so that the same may be liable to the payment of 1s. per share, and no more.

"3. That the liquidators be and they are hereby authorised and directed to procure to be allotted to every member of this company requiring the same, one share in the new company, with two shillings credited as paid thereon, for and in respect of every share held by him in this company, provided always that to entitle the members of this company to an allotment of such new shares, application must be made for the same in writing within ten days after the posting of a notice informing him of his right to apply for the same addressed to his registered address in the books of the company. If no such application is received by the liquidators within the time limited as aforesaid, the right of such members to receive such proportion of shares shall be absolutely at an end, and the liquidators, in order that the necessary capital may be promptly raised, and the liquidation closed, shall dispose of any shares refused or not applied for as aforesaid to any person or persons whether shareholders or not, at such price (if any) and upon such terms as the liquidators may think fit.

"4. That the liquidators be, and they are hereby authorised to continue the business of the company pending the transfer thereof to the new company, and to consent to the registration of the new company by the same or a similar name to that of the company."

In submitting these resolutions, the Chairman said before voting upon them it was necessary for them to consider what had brought them to the unfortunate necessity of winding up and reconstructing. As he had already shadowed forth, the directors alleged that it was entirely due to the maladministration of Mr. Watt during the time that he was managing director of the company. They found, when they came into office, everything in a most disordered condition; a balance of £2 16s. to the credit of the company at the Consolidated Bank, and writs from agents and others for payment of debts. The agents, properly appointed by Mr. Watt, but, the present board thought, quite unnecessarily, had not been paid their salaries for some considerable time, and there were other creditors for goods sold, work done, and so forth. They did the best they could, as he had already told them. They obtained ready money from the bank on their own personal security, and the creditors were satisfied. As soon as Mr. Watt, who certainly anticipated that they would not be able to carry on the affairs without him, or he would not have so readily resigned, found that they could do without him, he filed a petition for the compulsory winding up of the company. They opposed that petition, and successfully opposed it in this way: The Court decided that as there were matters of account between Mr. Watt and the company, the petition should be dismissed on the payment into a bank by the company of £500, in the joint names of the solicitors, to abide the result of the actions pending. The money had been deposited. Where did it come from? They (the directors) had to find it from their own pockets, merely to keep the thing going until the shareholders could be called upon to know if they would take up 80,000 of the unissued shares. After alluding to the circular issued by Mr. Watt prior to the last meeting, and again speaking of it as containing many incorrect statements and unfounded suggestions, the Chairman stated that in his letter just issued Mr. Watt said the directors' latest scheme was on an obsolete form which counsel advised him was illegal. Yet Mr. Watt was chairman of the Yuruari Company, which was once the New Chile Company, Mr. Watt having wound up the latter and brought out the Yuruari Company. With regard to Mr. Watt's suggestion that a high class professional liquidator should be appointed, they must remember that a high class liquidator, such as was indicated, would require high class remuneration. The liquidators had had pretty well half their work done by the report of Messrs. Boyce and Ramsay. The directors had an action pending against Mr. Watt for the return of a large sum of money, they had the threads of the whole business in their hands, and it would considerably reduce the cost of winding up to appoint them; for upon all those points it would be necessary to instruct and educate the high-class professional liquidator, which would take time, and his charge would be correspondingly larger. Moreover he might compromise in the matter of the action pending—come to some arrangement with Mr. Watt—but they never would do so; they would fight it out to the bitter end, because they had confidence in the result. But what about the future? Provided this scheme was carried, it would give them a capital of £15,300, which would be ample to enable them to continue the work. He regretted to say that during the last month they had been obliged to let contracts slip which had been offered them, and which would have brought them in a net profit of £1,500, a sum sufficient to pay a dividend of 2½ per cent. He did not know whether those contracts were altogether lost; he hoped not. Electric lighting was never so promising as at the present time, and the directors felt every confidence that if the shareholders took up the scheme and supplied them with the necessary capital, they would be able at the end of the year to come before them with a balance sheet that would show a very fair dividend. Mr. Watt had received seventeen proxies, most of which came from distant parts of the country. He appealed to those present who had given proxies to Mr. Watt to withdraw them, so that they could go to the court as unanimous in opinion. They would never regret it. Suppose they did not take up the scheme; suppose they stopped at the winding-up and did not reconstruct, what on earth would they get? At a forced sale they would get absolutely nothing.

Sir Henry Hart inquired what the assets of the company were valued at.

The Chairman replied about £12,000. Continuing, he said they had endeavoured to make the payments of 1s. per share, under the new scheme, as easy as possible. Concluding his remarks the chairman read a strongly-worded letter from a lady shareholder, who was evidently not fully aware of the real facts. She accused the directors of having helped themselves to the funds of the company, and said she was disgusted at the impudence of the printed proposal, which they did not even seem to know was illegal. He (the Chairman) sympathised with any shareholder who had bought his shares at par, and quite agreed that the affairs had been infamously muddled, but not by the present board. Instead of helping themselves to money, they had been doing nothing but find money since they had been on the board.

Mr. Henderson said there was a paragraph in the notice stating that provision would be made to meet shareholders who did not desire to go into the new scheme. What provision would be made?

The Chairman: That is provided by the Joint Stock Companies' Act.

Mr. Klenck seconded the motion, and said he thought the scheme was the only way out of the present difficulties. The directors had made the scheme as light as possible for the shareholders, and if they could not find 1s. a share to save their property it would be very hard. They had very valuable patents, and must not lose them if they could help it. They had taken the fictitious value off their machinery, and the capital would give them that credit and means which it was necessary for them to have at their backs befor they accepted any contracts.

Mr. Stent described some negotiations his firm had with Mr. Watt for lighting a large town near London, and said he would tell them why they fell through. They found that Mr. Watt nominally lent, but actually paid, to their engineer a sum of money to induce him to guarantee, as far as his influence went, that he (Mr. Watt) and the Maxim-Weston Company should have that contract. The day that came to their knowledge they closed their intercourse with Mr. Watt. The deduction which his colleagues and himself drew from their intercourse with Mr. Watt compelled him to confirm and support to the utmost of his ability the information which had been expressed there to-day as to the conduct of the company under the old directorate.

Sir H. Hoare said he had come to the meeting with what Mr. Gladstone would call a perfectly open mind, and he thanked the chairman for his extremely candid and explicit statement. He thought the company would prosper in the future, and hoped to give it all the support in his humble power.

Mr. Michael Abrahams said he had but recently become Mr. Watt's solicitor, and, so far, had not acted unsuccessfully in his behalf. He was not there to throw any difficulty whatever in the way of this reconstruction, it being the view of the shareholders that the company should be reconstructed; but he wished to put one or two questions, which would be an assistance to the liquidators in carrying it out. It was necessary, from a legal point of view, that certain things should be considered. The first question was: Who were to be the directors of the new company, because three of the present directors were to be the liquidators? He presumed the three liquidators would also be directors, there-

fore they would be the sellers and purchasers of the property. Then, what were they getting for the property?—300,000 shares with 2s. paid up. What provision was being made for dissentient shareholders? He prophesied they would have a large number of dissentient shareholders. They had fixed the value of the shares at 2s., and they would have to pay 2s. a share to each shareholder who dissented.

The Chairman: We differ from you there.

Mr. Abrahams said he should demand the payment of 2s. a share on behalf of every shareholder he represented. He asked what were the liabilities of the old company, which they would have to discharge, and what provision had been made for meeting them? Also what provision had been made as to the costs of the liquidation? With regard to Mr. Watt, very hard words had been said against him, and if he had been there he would have resented those words; seeing the feeling of the meeting, he thought he had acted prudently in staying away, for had he been present they might have had a scene of confusion that would not have been creditable. He complained of the references that had been made to the legal proceedings, seeing they were *sub judice*, and said Mr. Watt would account for every farthing of the company's money.

Mr. Spicer asked what were the actual assets possessed by the company. He was aware that the assets were to some extent pledged to the directors, who had provided the money for the necessary expenses of conducting the business of the company. Under the reorganisation scheme they were told that £15,000 would be provided, and he wished to know what they were to have for that money. The assets were stated to be worth £12,000. Did those assets really belong to the company? What was the actual value of the assets belonging to the company, and what were the liabilities.

The Chairman said the liabilities were as nearly as possible covered by the book debts, eradicating what they considered bad debts. Therefore they considered they had their plant and patents and so forth unencumbered. If they stopped where they were, that was to say, if they decided to liquidate but not to reconstruct, he was not going to say that the plant would realise anything like the sum he had stated, which was their value as the assets of a going concern. About a quarter of that sum would be about what they would have to divide if they wound up altogether. With regard to Mr. Abrahams' questions, the liquidators would be directors of the new company. The dissentient shareholders were expressly provided for under the Joint Stock Companies Act, under which the value of the shares was to be fixed by arbitration. As to the dissentients, the directors had friends at their backs who were willing to take shares to the extent of 100,000, if the directors could supply them, so they did not feel at all alarmed at Mr. Abrahams' saying they would have a large number of dissentient shareholders.

Mr. Abrahams: I say the arbitrators will fix the value of the shares at 2s.

The Chairman: We do not agree with you. The Chairman, continuing, said it would be the duty of the liquidators to provide for the dissentient shareholders. The expenses of the liquidation would be reduced to a minimum. The liquidators were thoroughly conversant with the affairs of the company, whereas "a high-class professional liquidator" would have to be made acquainted with them, and would charge for his time. The amount of the liabilities of the old company would range from £2,000 to £2,500, and they had book debts to meet them. The liquidators would have to provide whatever sum would be required for the dissentient shareholders by the sale of the shares.

Mr. Abrahams: And there is no other provision, I understand?

The Chairman: It is the duty of the liquidators to provide for it, and they will do so. With regard to the expenses of liquidation, I did not attempt to say anything about the amount of the charges. I merely said that the expenses would be reduced to a minimum.

Mr. Fern, on behalf of the lady whose letter had been read, disavowed any acquaintance on her part with Mr. Watt, and said she was quite satisfied with the information which had been given by the chairman, and now saw what the facts were.

The resolution was then put and carried, with three dissentients. The Chairman declared the whole of the resolutions carried by the requisite three-fourths majority.

A vote of thanks to the Chairman terminated the proceedings.

Telegraph Construction and Maintenance Company, Limited.—The directors intend to replace the existing debentures, which mature on the 1st January, 1889, with debentures to mature on the 1st January, 1894, and upon which interest will be payable half-yearly, at the rate of £5 per cent. per annum. Holders can have such debentures exchanged on and after the 2nd January, 1889, for an equal amount of £5 per cent. debentures. Existing debentures not lodged with the company before the 31st December, 1888, will be paid off in cash.

Brazilian Submarine Telegraph Company, Limited.—The directors of this company have declared an interim dividend of 3s. per share, or at the rate of 6 per cent. per annum, free of income tax, for the quarter ended September 30th last, and payable on the 24th inst. The books of this company will be closed from the 17th to 22nd inst., both days inclusive.

Mining and General Electric Lamp Company, Limited.—Letters of allotment in this company have been posted.

TRAFFIC RECEIPTS.

The Cuba Submarine Telegraph Company, Limited. The number of messages passing over the lines of this company during the month of November was 4,013, estimated to produce £3,100, against 3,343 messages, producing £2,998 in the corresponding month of last year. The traffic receipts for the month of August, estimated at £2,800, realised £2,860.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending November 30th, 1888, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £4,672.

The West India and Panama Telegraph Company, Limited. The estimated receipts for the half-month ended the 30th November are £2,880, as compared with £3,689 in the corresponding period of 1887. The August receipts, estimated at £5,002, realised £5,149.

The Direct Spanish Telegraph Company, Limited. The estimated receipts for the month of November were £1,050, against £2,115 in the corresponding period of last year.

The Great Northern Telegraph Company, Limited. The receipts for November, 1888, £24,000; January 1st to 30th November, 1888, £250,200; corresponding months 1887, £242,880; and of 1886, £239,000.

The Eastern Telegraph Company, Limited. The receipts for the month of November, 1888, amounted to £59,862, compared with £53,454 in the corresponding month of last year, an increase of £6,408.

The Eastern Extension, Australasia and China Telegraph Company, Limited. The receipts for the month of November, 1888, amounted to £45,234, compared with £39,200 in the corresponding period of 1887.

The West Coast of America Telegraph Company, Limited. The gross earnings for the month ending November 30th are £5,975.

The Brazilian Submarine Telegraph Company, Limited. The traffic receipts for the week ending November 30th amounted to £5,600.

NEW PATENTS—1888.

17063. "A new or improved electric spray-producing apparatus." H. A. B. HUGUET (DE VARS). Dated November 23. (*Complete.*)

17123. "Improvements in apparatus for electrically regulating or synchronising clocks." C. A. MAYRHOFER. Dated November 24. (*Complete.*)

17127. "Improvements relating to the conveying of electrically-charged wires." D. Y. CLIFF. Dated November 24.

17163. "Improvements in electrical switches and other electrical instruments." F. L. RAWSON and W. WHITE. Dated November 26.

17178. "Improvements in electric motors." W. M. MORDEY. Dated November 26.

17222. "Improvements in electric lamps or lighting apparatus." L. PAGET. Dated November 27. (*Complete.*)

17223. "Improvements relating to electric secondary batteries or accumulators and to the manufacture of electrodes therefor." L. PAGET. Dated November 27. (*Complete.*)

17224. "Improvements in and relating to electrical apparatus for propelling tramway and other vehicles." L. PAGET. Dated November 27. (*Complete.*)

17225. "Improvements relating to the generation of electricity and the simultaneous production of zinc chloride and other bye-products." L. PAGET. Dated November 27. (*Complete.*)

17238. "Improvements in or relating to dry piles for electrical purposes." G. C. DYMOND. (Communicated by L. Moorthamers, Belgium.) Dated November 27.

17249. "An improvement in electric meters." F. TEAGUE. Dated November 27.

17267. "Improvements relating to electric apparatus for propelling tramway cars and other vehicles, and to means for transmitting electric currents to such apparatus." H. H. LAKE. (Communicated by J. Kames, United States.) Dated November 27. (*Complete.*)

17276. "Improvements in and relating to portable galvanic batteries." W. J. S. BARBER-STARKEY. Dated November 28.

17289. "Improvements in gearing for electric tramcars, &c." H. W. HOULDEN. Dated November 28.

17325. "An improved combined electrical bell, battery, and push, for street-door and other purposes." A. W. ARMSTRONG. Dated November 28.

17326. "The adaptation of electricity or clockwork in conjunction with either lenses, reflectors, or an aphengescope, or combined to transmit different advertisements automatically without manual power. A. W. ARMSTRONG. Dated November 28.

17340. "Improvements in electro-depositing cells." P. M. JUSTICE. (Communicated by E. L. Smith, United States.) Dated November 28. (*Complete.*)

17353. "Combination automatic commutating and electric fire and police alarm and public alarm." G. DURHAM. Dated November 29.

17394. "Improvements in electric lampholders." G. BINSWANGER and H. HIRST. Dated November 29.

17420. "Improvements in the method of and in machinery for the manufacture of metallic pipes and rods, and for covering the same, and telegraph and telephone cables and wires, with lead or metallic compounds for electric purposes." A. WYLIE. Dated November 29.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1887.

14729. "An improved meter for measuring electrical currents." W. H. DOUGLAS. Dated October 29. 11d. Claims:—1. An improved meter for measuring electrical currents, consisting of the use of two thermometers, one of which is affected by the electrical current. 2. Connecting two thermometers by a differential gearing of wheelwork, whereby the quantity of electrical current passing is indicated by means of a hand upon a dial. 3. The introduction of the snail for the purpose of measuring electrical currents. 4. The general combination of thermometers and clockwork, substantially as set forth, for the purpose of measuring electrical currents.

14834. "Improvements relating to the regulation of steam engines and other motors for working dynamo-electric machines or electric generators." W. R. LAKE. (Communicated from abroad by C. L. R. E. Menges, of The Hague.) Dated October 31. 8d. Relates to a modification of the apparatus described in letters patent dated January 5th, A.D. 1887, No. 168.

15118. "Improvements in electric incandescent lamps." W. CLARKE and C. A. PARSONS. Dated November 5. 8d. The inventors provide a support which, although not in actual contact with the rod or burner, is in close proximity to it on either side, and being attached to the glass globe, prevents the burner vibrating except through a very small angle, and consequently obviates the injurious effects of a sudden blow. The claims are 2 in number.

15161. "A coin-freed electrical current-producing apparatus." P. EVERITT. Dated November 7. 8d. The inventor takes any suitable magneto or dynamo-electric machine that can be actuated by rotary, reciprocating, oscillating, or other well-known mechanical movement by means of hand power, and he connects one of the handles of the machine to one terminal of the electric machine. He also connects a suitable stop to this handle, so that it cannot be moved until a coin, or the like, is inserted in the apparatus to release it. This he effects by causing the weight of a coin to move a lever, which in its turn releases a lever or stop attached to the handle. The claims are 4 in number.

15735. "Improvements in electrical indicating or signalling apparatus." W. R. LAKE. (Communicated from abroad by C. Grivolas fils, of Paris.) Dated November 16. 8d. This invention comprises:—1. Two coils, each provided with a core of soft iron, mounted upon a support likewise of soft iron, which is common to the two coils having insulated copper wire. 2. A bar or magnetised hand, mounted horizontally upon a pivot of steel, through the medium of a bracket of copper made in one piece with the part that serves to fix the whole of the system with, comparatively speaking, no friction, which renders the apparatus very sensitive. Above the hand, and upon the prolongation of the shaft, is fixed a piece in the form of pincers, designed to receive the cardboard carrying the indication; this cardboard is mounted in such a manner that, according to the movement of the magnetised bar, which describes rather more than a quarter of a revolution, it presents its face sometimes to the front, sometimes turned a little more than the profile. The claims are 6 in number.

15922. "An improved spring jack for telephonic and other electrical purposes in which it is desired to change or switch a current from one conductor to another." A. COLEMAN, H. F. JACKSON, and E. L. DUDLEY. Dated November 19. 8d. Claim:—The means of ensuring proper electrical connection between the spring and slipper of any ordinary or special form of spring jack, by the provision of a secondary spring, either in the form shown in the drawings or in any other form answering the same purpose, substantially as described.

16217. "Apparatus for [automatically conveying and delivering letters and small parcels by electricity." F. C. ALLSOP. Dated November 25. 8d. Relates to apparatus for automatically conveying and delivering by electricity letters and small parcels from one place to another (such as from the lodge gates to the house) by means of electric trucks or carriers controlled by automatic electrical or mechanical switches. The claims are 4 in number.

16324. "Improvements in electro-mechanical striking gongs." F. T. SCHMIDT. Dated November 28. 8d. The object of this invention is to operate the striking hammer of mechanical gongs by means of electricity, and in such a manner that the hammer is only operated so as to give one stroke for each time the electric circuit is closed, whether it be closed for a short period or for any length of time, the result to be the same, that is only one stroke of the hammer, and before another stroke can be made the circuit must be broken and then the contact closed as before. The claims are 3 in number.

16378. "Improvements in or relating to switching, feed, and call appliances for autographic telegraph systems." H. J. ALLISON. (Communicated from abroad by the Writing Telegraph Company, Incorporated, of New York.) Dated November 29. 8d. Relates to autographic telegraphs, and particularly to that class of autographic telegraphs described in the letters patent of Great Britain granted November 30th, 1886, No. 15,577, as a communication from the above-named the Writing Telegraph Company, Incorporated. The object of the invention is to render apparatus of the nature in question more effective in operation, and to obtain increased facilities when such apparatus are employed in a system of interchange between subscribers within a district. The claims are 17 in number.

16870. "Improvements in electro-dynamic generators and motors." R. TATHAM. Dated December 8. 8d. Relates to apparatus in which rotary motion is given to an armature or its equivalent for the generation of electricity, or in which electricity is used to cause the said armature to rotate. The armature or its equivalent of such machines is provided with a commutator which rotates in contact with brushes or suitable conductors, and the object of the invention is to provide means whereby the durability and efficiency of the said armature is increased. For the above purposes: 1. The inventor gives to-and-fro motion to the brushes or conductors in the direction of the longitudinal axis of the said armature. 2. He provides carriers and connections, whereby the desired motion is imparted to the said brushes or conductors. 3. He provides apparatus capable of being thrown into and out of contact with the commutator for the purpose of truing, polishing, and maintaining the said commutator circular in cross-section. The claims are 3 in number.

17031. "Improvements in or relating to the regulation of electric currents and in apparatus therefor." W. LAHMEYER. Dated December 10. 8d. Consists essentially in causing a solenoid formed by several spirals of the main current lead to act upon a movable armature, so that the movement thereof depends upon the intensity of the main current, said movement causing resistances to be interposed or excluded from the line, that is to say, the resistance thereof to be increased or diminished in inverse proportion to the variation of the intensity, so that the loss of electromotive force which is equal to the products of these factors shall remain constant. The claims are 6 in number.

PROCEEDINGS OF SOCIETIES.

Physical Society, November 24th, 1888.

Prof. REINOLD, President, in the Chair.

The Rev. T. Pelham Dale and Dr. R. M. Walmsley were elected members of the society.

Captain ABNEY read a paper "On the Measurement of the Luminosity of Coloured Surfaces," which was illustrated by experiments. In a communication to the Royal Society, General Festing and the author have described a method of comparing the intensity of the light of different parts of the spectrum, reflected by various pigments, with that reflected from white; and luminosity curves have been constructed, the areas of which give comparative measures of the total luminosities. This method of comparison is accurate, but requires considerable time, and the author has devised a more rapid process. The coloured surface, whose luminosity is to be compared with white, is placed beside a white patch within a dark box. A direct beam of light passes through an aperture in the box, and a black rod casts a shadow on the coloured patch; another beam from the same source is reflected at an angle, and forms a shadow of the same rod on the white patch, the junction of the two shadows coinciding with that of the two surfaces to be compared. In the path of the direct beam is placed a rotating disc with angular openings, adjustable whilst rotating by a simple lever, and by this means the white patch can be made to appear too light and too dark in rapid succession. By gradually diminishing the range of oscillation of the lever a position of equal luminosities can be found. The coloured surface is now replaced by a white one, and the adjustment again made; and from the angular apertures required in the two cases the relative luminosities are determined.

Comparisons made in this way (the numbers relating to which are given in the paper) with emerald green, vermillion, French ultramarine, &c., gave results in close agreement with those deduced from the luminosity curves obtained by the spectrum method.

In reply to questions, Captain ABNEY said the spectrum method was the more accurate, and could be relied on to 1 per cent. The new method gave results within 2 per cent., showing that the eye is very sensitive to small changes of luminosity when such changes take place in rapid succession.

Prof. RUCKER made a communication "On the Suppressed Dimensions of Physical Quantities." In arranging a system of dimensional equations for thermal quantities, the question arises as to what are the dimensions of temperature. A degree of temperature as measured by the ordinary arbitrary method of the mercurial thermometer is not affected by changes in the units of length, mass, and time, but the numerical values of thermal quantities (J, for instance) depends on the scale of temperature adopted, say Centigrade or Fahrenheit. Two courses seem open, either of which renders a complete system of thermal dimensional equations possible—1st, Temperature may be considered as a measure of energy, as in the kinetic theory of gases; and may be expressed as the energy of translation of a standard number of molecules, say, that number contained in 1 c.c. of arc at standard pressure and temperature; or 2nd, Temperature may be considered as a secondary fundamental unit. If the first be adopted, the dimensions of specific heat become M^{-1}, and the temperature of 0° C. is expressed by $1{\cdot}5207 \times 10^6$ ergs. If a practical unit corresponding to $\frac{10^8}{18}$ ergs be adopted, this new unit of temperature will coincide with the Centigrade degree to about

1 part in 3,000. The chief objection to such a definition of temperature is, that the above relation between temperature and energy is not yet proved to hold for liquids and solids. If the second course be adopted, the dimensions of all thermal quantities may be expressed in terms of M, L, T and θ, where θ is the unit of temperature. Attention was directed to the difficulties students generally experience on finding the dimensions of the same electrical quantities to be different, according as they are expressed in electrostatic or electro-magnetic measure, and that different quantities may have the same dimensions. The anomalies are shown to be due to the suppression of the dimensions of specific inductive capacity and permeability, each being called unity in air. By retaining κ and μ in the dimensional equations, the author thinks that many difficulties will be avoided, the method of transformation of units will be generalised, and the limits of our knowledge kept more clearly in view. Though the dimensions of κ and μ cannot be determined, it is easily shown that those of the product $\kappa^{\frac{1}{2}}\,\mu^{\frac{1}{2}}$ are $L^{-1}\,T$.

Mr. BLAKESLEY in commenting on thermal units, strongly protested against the use of the word "*Therm*" as a name for the unit of heat. If used at all it should be reserved for the unit of temperature. Referring to the choice of fundamental units he reminded the Society that the dimensions of quantities expressed in the electrostatic or electromagnetic systems become identical if the unit velocity be the velocity of light, and by choosing the unit of time as a suitable decimal part of a day, the relations between electrical and practical mechanical units could be simplified.

Prof. CAREY FOSTER, after discussing the effects of defining specific heat as a ratio, or as a quantity of heat on the dimensions of temperature, pointed out that a quantity of heat = temperature × entropy, the dimensions of temperature would be determinate if those of entropy were found.

Prof. S. P. THOMPSON considered part of the difficulties of dimensional equations arose from the fact that no distinction was made between *scalar* and *rector* quantities. Thus the dimensions of work, and moment of a force are given as $M\,L^2\,T^{-2}$, whereas the true representation for the latter would be $M\,L^2\,T^{-2}\,\sqrt{-1}$, because the line by which the force is multiplied is at right angles to the force. By similar considerations Ampère's rule for the force between two current elements, can be derived from the magnetic equation $\frac{m\,.\,m'}{r^2} = f$, for replacing m and m' by equivalent current elements, $i\,.\,d\,s$, and $i\,.\,d\,s'$, the equation becomes

$$f = \frac{\sqrt{-1}\,i\,.\,d\,s\,.\,\sqrt{-1}\,i\,.\,d\,s'}{r^2} = \frac{-\,i^2\,d\,s\,.\,d\,s'}{r^2}.$$

Referring to the use of *therm*, Dr. Thompson concurred with the remarks of Mr. Blakesley, and thought the word "*calorie*" answered all requirements. He also considered that thermal equations were greatly simplified by always expressing specific heat in ergs.

Prof. AYRTON was of opinion that students experienced much greater difficulty in dealing with electrical units than with thermal ones, and thought part of this was due to the vague way in which some of the standard text books treated the subject. With reference to the force exerted by quantities of electricity, Prof. Perry and himself had pointed out that specific inductive capacity must be taken into account, for, contrary to Faraday, they had found it to be different in different gases.

In reply, Prof. RUCKER said he often explained the identity of the dimensions of work and moment of a force, by considering moment as measured by the work done in rotating through unit angle, the dimensions of angle being zero, as regards L, M, and T. He also pointed out that in Bayne's thermo dynamo specific heats are always expressed in ergs.

In thanking Prof. Rücker for his interesting paper, the PRESIDENT expressed his conviction that by paying attention to the points considered, the difficulties arising from the two systems of units would be considerably diminished.

AMERICAN NOTES.

By DAS TELEPHON.

HAD not the microphone been invented there is no doubt that the electric telephone would have remained a simple electrical toy, and the transmission of speech to a distance—true, not to a very great distance—would be accomplished by the mechanical telephone. To the microphone is the world indebted for that great convenience—now a necessity in all business communities. In 1854 a perfect magneto receiver was invented by Charles Bourseul, but, alas, there was no instrument capable of transmitting electrical impulses sufficiently rapidly to actuate Bourseul's receiver so that speech could be reproduced. There is no doubt of the invention of the magneto receiver in 1854. It was described in a worked published in that year, as is stated in the opinion of the Supreme Court of the United States, rendered March 19th, 1888, in the famous Bell case, to which your readers are referred for the description, viz., "An electro-magnet in combination with a disc sufficiently flexible that it will lose none of the vibrations of the voice."

From 1854 to 1877 this little instrument of Bourseul remained unused and forgotten. Philip Reis even did not bring it out from its hidden place, and it remained for Prof. Bell to avail himself of the republication of its description in a book entitled "Wonders of Electricity," published in New York in 1872, at the very time Prof. Bell was occupied in his "*Multiple Telegraph*," and in his patent of March 7th, 1876, he substituted for Bourseul's iron discs a tympan of goldbeater's skin with an iron swinging armature, attached at one end to the centre of the tympan. This device (invention?) was made by Bell before February 14th, 1876, the date of his application for a patent in the United States. Bell admits that when he filed that application he had never obtained articulate speech with any of his devices. No one, it seems, discovered that Bell's device was a bad imitation of Bourseul's perfect magneto telephone, although "Wonders of Electricity," containing Bourseul's description was largely circulated. This ignorance by the public of Bourseul's invention permitted Prof. Bell to adopt the iron "disc" of Bourseul and claim it in his second patent, that of January 30th, 1877, in the 3rd claim, which is in the following words: "the combination with an electro-magnet of a plate of iron or steel. . . ." Is not that description of Bell's device identical with the description of Bourseul's instrument of 1854, as given by the Supreme Court of the United States.

From 1854 to 1877 Bourseul's perfect magneto receiver waited for the microphone, and the voice of man remained confined to its narrow limits imposed upon it in the garden of Eden.

1877 came; April 17th came, and on that day there was placed on the files of the United States patents a full description of a perfect microphone. An instrument made of materials capable of conducting electricity having loose joints—the embodiment of the principle of the microphone upon which all microphones must act. The inventor is Emile Berliner, at present a citizen of Washington.

The application filed on April 17th, 1877, was in the nature of a caveat, which is filed in the secret archives of the patent office, and no one except the examiner in charge of the application has any right to see the application.

Not only does that application describe and claim the microphone, but it also names carbon as an excellent material in its construction. Prof. Edison filed an application for a carbon transmitter on July 20th, 1877, but a patent was refused on the ground that Berliner had previously claimed the invention. The two claimants were put in "interference" by the Patent Office, and there the case remains undecided, for the simple reason that the American Bell Telephone Company owns both the inventions.

I am well aware that Prof. Hughes invented a carbon microphone in 1878, and there cannot be any doubt that he did invent it without having any knowledge of the invention in the United States. To *Emile Berliner* is due the credit of the invention of the microphone, as also of the carbon contacts in a microphone; but this is not his only really great invention. A few weeks ago I visited Mr. Berliner's laboratory, or rather his workshop, and I found him in his working-day clothes and apron busy on his latest invention the "*gramophone*."

I sat down some 20 feet distant from his large trumpet, Mr. Berliner sat by the table behind the trumpet and slowly turned a small crank, and I heard all around me the following pieces of music:—

"A little German march," by 4 brass instruments.
"Warrior bold."
"A Venetian serenade."
"Cornet solo."

The execution was excellent and the tunes so loud that I heard well while walking about the room and into the passage.

Mr. Berliner then showed to me the process of preparing the plates and recording thereon the air waves produced by the voice in speaking.

He took a flat smooth disc of zinc, 12 inches in diameter and one-eighth inch thick, he poured upon it a liquid which looked like pale oil, which he termed "digested fat," a very slight film remained on the disc, having become dry in half a minute; he repeated the same operation, and after about one minute he plunged the disc into cold water for half a minute, the disc, also the water at its surface, was coated with a fatty substance. He then placed the disc on the revolving table; I was then asked to speak against a small tympan about two inches in diameter, having a point of a common darning needle projecting from its cetre resting on the disc, which was revolved by Mr. Berliner. When I had finished speaking Mr. Berliner placed the disc in a basin filled with acid, where it remained about twenty minutes. He then took the disc out of the acid and washed off the remaining fatty substance, and with a magnifying glass I saw the wavy curved lines which had been eaten into the zinc disc, which was then put on the turning table and the same device into which I spoke was set with the point of the needle in one of the concentric lines; the disc was turned, and I heard all that I said clearly and distinctly and loudly reproduced. I could not recognise my own voice, of course—no one can recognise his own voice. About two hours afterwards I took a lady with me to hear the "gramophone," the same programme of music was repeated, and when the disc with my recorded words was revolved on the table the lady immediately looked at me with wondering astonishment and exclaimed, "Why, that is your voice."

I append a paper on "the gramophone" which I have carefully prepared for the REVIEW, and I send a photograph of Emile Berliner the inventor of the microphone.

Emile Berliner was born in Hanover, Germany, 1851, and came to United States 1870.

Baltimore, *November 23rd*, 1888.

PHENOMENA PRODUCED BY ELECTRIC DISCHARGES ON EASTMAN'S PELLICULAR PAPER.

By M. E. L. TROUVELOT.

If we effect a discharge from the positive pole of an induction coil upon the sensitised surface of a sheet of Eastman's negative paper, we perceive the ramifications of the spark designed in marks of fire upon this surface, and on developing we obtain a bold image comparable to that obtained by the same process on glass plates. If we make the same experiment with the negative pole the results are different; we recognise then only some short ramifications upon the pellicle. If we raise up slightly the corner of the pellicle, we observe that the line of fire has traversed the pellicle and the paper, and continued its course to the surface of the plate of glass supporting the condenser on its opposite side. On developing, the marks perceived on the pellicle appear rapidly, and it is perceived that they are considerably thickened at certain points, and much resemble certain mosses which grow upon the branches of trees. These mossy portions often terminate in the form of a club at the very point where the luminous line traverses the pellicle, as if their formation was due to the resistance offered by this pellicle to the passage of the spark. If we carry out the devolopment of such a proof, we see traces, more or less distinct, of the ramifications which have been produced under the pellicle which is found impressed on its lower surface through the paper.

If we take a proof thus obtained when it is fixed and well dried, and after placing it on the condenser we cause a discharge of the coil to take place upon the corresponding point where the first discharge has taken place, we observe a singular phenomenon. If we discharge the *negative* pole upon a proof which gives an image of *positive* electricity, we remark from the first discharge faint whitish lines, which lengthen and widen gradually after other discharges which succeed to the first; these whitish lines, which look as if finely drawn with chalk, follow exactly the ramifications of the positive proof in all its branches. If we make a similar experiment by discharging the positive pole upon an image of the negative electricity, nothing similar appears, whatever is the number of the discharges produced.

We often see the images given by the discharges of the positive and negative poles intermixed in the same proof. If we direct discharges of the negative pole upon the same proof, we see gradually the positive ramifications appearing white, whilst the negative ramifications remain unaltered, except where these ramifications are accompanied by positive lines following the same track. Similar experiments made with proofs on glass give no result.

If examined with the microscope, these whitish lines seem to result from thousands of minute blisters of the pellicle, doubtless occasioned by the rise of temperature due to the passage of electricity over the same lines.

These experiments show anew the difference of the characters of the opposite electricities, and prove that negative electricity possesses a power of penetration far greater than that of positive electricity.—*Comptes Rendus.*

THE ELECTRIC LIGHT QUESTION IN KENSINGTON.

The question of electric lighting in Kensington, with which we dealt in our last issue, has now assumed a more practical and a more promising aspect. When the vestry again met to consider the matter, the special committee's report having been sent back to the committee as being unsatisfactory, Mr. Lindsay, who seems to be the only member of the vestry who approximately understands the subject, explained that he intended to move the following series of resolutions upon the committee's report:—"That the committee be instructed to report how far the vestry can arrange with the various companies applying for licences or Provisional Orders for electric lighting in Kensington, so as (*a*) To prevent any one company having a monopoly of any one district, and so as to prevent more than two companies obtaining power to open any one street. (*b*) To prevent the erection of overhead wires, except as a temporary expedient, with the consent of the vestry, and to ensure the taking down within three years of any such overhead wires as may be temporarily permitted. (*c*) To prevent any claim arising on the part of any company for damage done to underground wires on the occasions of the roads being repaired, unless such damage be caused wilfully or by unworkmanlike conduct of persons in the employment of the vestry; also that the committee be instructed to inform the vestry, as far as practicable, in relation to any company in favour of which they may recommend that the vestry should consent to the granting of a licence or Provisional Order: (*a*) What is the paid up capital of such company subscribed by *bona fide* shareholders? (*b*) Where such company has, or proposes to erect, its machinery? (*c*) What amount of electric light has been hitherto supplied, and in what place, or places, by any such company. (*d*) Whether any such company itself undertakes the preparing the internal arrangements of premises for the reception of the electric light, or what conditions any such company is accustomed to make in relation to this matter."

Urging the vestry to say definitely whether or not they approved of the monopolies suggested by the committee, Mr. Lindsay mentioned two circumstances of a curious, if not a suspicious nature. The first was that (as he was informed) the London Electric Lighting Company had offered to supply the whole of the light for Kensington at a wholesale price, and to allow the vestry to make a retail profit. If that were true, the committee ought to have stated it; but they had hardly been candid with the vestry. The second circumstance was that when the company referred to asked the committee to visit their works in order to see whether they were able to carry out the undertaking, the committee curtly replied that they had not time to go to Deptford, although they had found time to go to Eastbourne to inspect the installation in that town.

With regard to a suggestion that only those companies who had works in Kensington should be allowed to light the parish, in order to facilitate the acquisition of the installation at the end of twenty-one years, Mr. Lindsay argued that such a position ought not to be taken up, for not only was such a contingency remote, but it was absolutely certain that in time local government would be so perfected as to obliterate local authorities, so far as lighting was concerned. As to the 21 years' limit proposed by the committee (to which we drew special attention), he pointed out, as we did, that the Act of 1882 was passed with that provision, but it was found impossible under that limit to get the capital subscribed to develop electric lighting. The Legislature therefore enlarged the period to 42 years, and yet the committee had decided to make a condition of that which Parliament had said should not be a condition. If, he further argued, companies were willing to surrender their rights at the end of 21 years, that led to the inference that they were not financially strong, and wished to obtain a concession which would make them stronger, and the vestry should be especially careful not to give such a concession. Another point Mr. Lindsay pressed was, that if any company made it a condition that they alone should put up the lighting machinery in houses, that pointed to a desire to make a large profit from that source alone, and after that they would probably pay little attention to fulfilling their obligation to supply the light. Disclaiming the slightest interest in any electric light company, Mr. Lindsay again condemned the proposal to restrict consumers in their choice of a company from which to obtain the light, and then moved his resolutions.

The motion having been seconded, a member of the committee (Mr. Wilson) asserted that the first steps taken by the committee were for the prevention of monopolies, and that there had been no point raised before the vestry which the committee had not thoroughly sifted. Mr. Duffield supported the committee, and prophesied that if the proposed instructions were carried out, the public might cease to expect the electric light for years to come. He further suggested that the object of the opposition to the committee's recommendations was to bring in a gigantic company and create a huge monopoly. After some further discussion, Mr. Lindsay consented to withhold his resolutions for a time, and the whole matter was once more referred back to the committee for further consideration and fuller report. To strengthen the committee and equalise the representation, six additional members were appointed. This action, and the fresh light thrown upon the question by Mr. Lindsay, should lead to an early and satisfactory solution; but it seems a fatality that progress in connection with the electric light in this country should be slow and uncertain.

ELECTRIC LIGHT FOR MILITARY PURPOSES.

WE have just, says the *Elektrotechnisches Echo*, had occasion to witness some nocturnal experiments in rifle shooting by the aid of the electric light in a large garrison, and we may say that all the participators in the trials were exceedingly well satisfied with the result. Already last year some similar trials were made by the artillery at Jüterbogk, when the bursting of shells could be distinctly seen at a distance of 2,700 metres. On the present occasion the light was found also to answer well for rifle shooting. The night was dark, a few stars only being visible. At a distance of 400 metres were fixed figures and circular discs as targets. The electrical apparatus was posted 200 metres behind the firing party, and consisted of a waggon carrying a steam engine, a dynamo-electrical machine, and a reflector. The engine was of 18 horse-power, and the lamp an arc lamp, whilst the machine was situated 200 metres from the reflector and worked the same by a wire. The light thereby became perfectly steady without the least flickering. When working with 7 horse-power the machine threw a beam of light to a distance of 4,000 metres, and at that distance pencil writing could be read.

When the trials began we placed ourselves next to the machine, whence we were able to see distinctly the targets, so that it would have been impossible for anyone to have approached within the focus of the light or got near the machine unseen. This would have been the more impossible, as the micrometer action of the reflector enabled the operator to sweep the horizon.

The shooting trials were carried out in the following manner:—The soldiers lay partly in the focus of the light itself so that the sights were sharply illuminated, and these men hit the circular targets at man's height nine times out of ten. Another squad of men lay in darkness firing at the illuminated targets, and their firing was hardly inferior to that of the former.

However, preference must beyond doubt be given to the former method in war, as it is utterly impossible for the enemy to see their opponents when lying in the dazzling light. But if the men lie in darkness the enemy will easily discover them through the flash of their guns.

As regards the electrical apparatus it can only be rendered unserviceable by a bullet hitting the bar to which both carbon points are fixed, as even if a bullet break the glass in the reflector the light will not be affected in the least. One moment only is of danger to the apparatus, namely, that when the carbon points are being changed, when, if the force be too great, the apparatus may cease to act. If so, the otherwise intensely white light assumes a violet hue, and in a few seconds the reflector ceases to act, and the disc looks like the moon rising when full, shining with a dull red lustre. At that moment the enemy may destroy the apparatus with the greatest ease by throwing shells at it. It must, therefore, be the chief task of the electrical engineers to take care that the apparatus is kept working steadily and evenly.

The electrical waggon belongs to the engineer train corps, and will therefore, as the name indicates, only be employed against an enemy or in our forts, as for use in the field it is too heavy.

REVIEW.

Electric Bells and All About Them. A practical Handbook for practical men. By S. R. BOTTONE. London: Whittaker & Co., Paternoster Square, E.C.

The statement that this book is "A practical Handbook for practical men" exactly expresses what the work really is. We have no hesitation in speaking most favourably of the production. The descriptions are full of details, which is exactly what the novice requires. The "preliminary considerations" (Chapter I.) are perhaps rather unnecessarily diffuse as there is a great deal given with which the practical bell hanger has really no concern. The same remarks also apply to Chapter II., where forms of batteries which are perfectly useless for electric bell work are described and their action explained in detail. No information, moreover, is given which really indicates the amount of battery power which would probably be required in any particular cases. We think the work would be improved if some information were given as to where the various materials required for electric bell work could be procured and also the approximate prices for the same, though possibly such a course would lead to the usual jealousy amongst manufacturers from *their* names being left out of the list when *they* are able to sell better and cheaper articles than anyone else in the trade.

CORRESPONDENCE.

Ocean Temperatures and Submarine Cables.

I have to reply to your correspondent who appears to have converted himself into a nameless individual.

In the first place I wish to thank him for his doubtless well-meant intentions in pointing out the error existing in my figures as published for the relative effect of pressure and temperature on gutta-percha at 2,000 and 3,000 fathoms. It would naturally, I imagine, be apparent that this was only a "slip," as I had already referred to the fact (attained from Sir Wm. Siemens's experiments) that the resistance was increased at a rate directly proportional to the amount of pressure exerted.

It does not, however, alter the general inference that the greater the depth the larger is the share which pressure takes in proportion to that taken by low temperatures in increasing the resistance on submergence, though it materially defers the depth at which the pressure has an equal effect on the resistance of gutta-percha with that of the bottom temperature. My example was, however, only intended to give an illustration of the comparative effects of pressure and temperature at various depths. If it had been intended for anything more I should not have spoken of it as the effect produced on gutta-percha generally, but rather on a particular gum of the same. In referring to the matter further I should have required to state the manner in which the different gums of gutta-percha are affected by the temperature at any depth; for instance, the resistance of some gutta-percha gums, just supposing that they also, at some different degree of age, had a resistance of 600 megohms at 75° Fah., would be increased from 600 megohms at 75° Fah. to 11,641 megohms at 36° Fah., instead of to 6,737 megohms as in the case given; whilst that of other qualities would

become only 3,373 megohms by the same decrease of temperature.

As regards the other points brought up in your correspondent's letter, I still fancy that 102·38 per cent. is at the present time "quite an ordinary conductivity for copper intended for telegraphic purposes;" neither do I think it "will come somewhat as a surprise to those engaged in the testing or manufacture of cables" as suggested by your correspondent.

In stating that "the correct coefficient for variation of resistance by temperature is frequently somewhat higher than that given for Dr. Matthiessen's standard," I referred to each particular coil composing a cable and not, as your correspondent I think supposes, on any entire length of cable in which he rightly points out "an average conductivity of 98 or 99 per cent. is generally considered an excellent result"—96 per cent. is usually about the conductivity stipulated in specifications for each hank of copper wire composing a submarine cable.

I did not wish to be understood that the *average* conductivity was as high as 102·38 per cent., but that inasmuch as such conductivities above 100 per cent. occur frequently in the hanks of wire, the correct coefficient for temperature would be frequently above that given for Matthiessen's standard pure copper, and on a completed cable the average conductivity is therefore often as high, or possibly even slightly above, that of Matthiessen's standard, and therefore it is not unlikely that the absolutely correct temperature coefficient of the conductor would be often as high as (or, indeed, higher than) that for the standard copper.

As long ago as in 1883 Mr. Willoughby Smith, in his presidential address to the Society of Telegraph-Engineers, gave results of experiments on the conductivity of several samples of copper wire, in which some showed themselves to have a higher conductivity than Matthiessen's standard. Commenting on the same, Mr. Smith said: "These results confirm what I have already mentioned, that some commercial copper has a higher specific conductivity than the long-recognised standard for pure copper."

If conductivities of 101·4 per cent. were attained in 1883 (instead of 50 per cent. in 1858) it is less than only natural that such conductivities as 102·4 per cent. should not be uncommon nowadays. In point of fact, if your correspondent tested the copper wire of a certain French firm he would not, I fancy, find any samples with the conductivity below 101 per cent.

Previous to your correspondent's remarks I was not aware that any doubt existed as to the desirability of a fresh copper standard being, before long, adopted. Your correspondent implies that I suggested that the temperature coefficient for the resistance of the copper conductor should be *determined* by observing its resistance at various temperatures as denoted by variation in the resistance of the gutta-percha dielectric of any cable. It certainly was not my intention to suggest any such notion. What I wanted to point out was, that when an opportunity presented itself of observing the resistance of the gutta-percha dielectric as well as of the copper conductor of a cable at wide ranges of temperature of known degrees, it was useful to do so; as in the case when a cable is taken out from England in the winter at an atmospheric temperature, say, of 35° Fah., and passes through the tropics at a water (tank) temperature of 85° Fah., and then afterwards in going south experiences a temperature of, say, 32° Fah., and then again an equatorial temperature of 80° to 90° Fah.

In the first place the opportunity is one which it is well to take advantage of (from a scientific interest point of view, at any rate) in order to observe the rate at which the resistance of gutta-percha answers to a change of temperature of known degree as compared with that of copper. Where a cable is coiled in the tank aboard ship, the temperature of the water may be noted, and after a change of the temperature of this water it is useful to note how soon the copper picks up that temperature (as regards its electrical resistance) and how soon the gutta-percha does so.

It might in some ways naturally be supposed that the copper conductor being enveloped inside the gutta-percha insulator, that the gutta-percha would, especially in the case of a laid cable, the soonest adapt itself to any alteration in the prevailing temperature. This does not, however, appear to be the case; in fact, the gutta-percha insulator, as a rule, lags behind the copper in this respect by about 48 hours in the case of a variation of temperature of about 30°; *i.e.*, it takes the gutta-percha dielectric about 48 hours longer to take up this change of temperature (so far as its resistance is concerned) than it does the copper conductor. This is very probably owing to the fact that, in the case of gutta-percha, the effect of a change of temperature is (by increasing or decreasing its density) that of gradually driving out, or absorbing, moisture, and thus gradually increasing or decreasing its electrical resistance, whereas in that of a metal it is merely that of altering its degree of homogeneousness.

On a long outward voyage, passing through a large variation of temperature, by noting the insulation resistance at each of these temperatures as they respectively recur at various stages of the voyage, the variation of resistance due to *age* can be approximately determined, and the altered degree of variation of resistance due to each variation from the standard temperature (owing to the alteration in *specific* resistance by age) can be determined for the cable when it is about to be laid. In this way useful curves may be drawn up showing the variation of resistance by age, and that by temperature of different gums of gutta-percha; and another showing the respective variations by temperature of the said gums at various periods since manufacture of the core.

Inasmuch as the resisiance of gutta-percha takes so much longer to answer to a change of temperature than copper does, it might in some cases (as in that of a cable just laid in very cold water) be inaccurate, strictly speaking, in reducing the observed dielectric resistance to that of 75° Fah., to correct the resistance by the temperature calculated from the conductor resistance, owing to the fact that the gutta-percha may not have yet adapted itself (as regards its resistance) to such a low temperature as the copper has. Under these circumstances it is sometimes a little useful (even in practice) to calculate the temperature of the dielectric from its resistance, as an additional check on that attained for it by the resistance of the conductor, and by the thermometer at intervals.

This only is what I wished to imply in my previous remarks on the subject.

In this case the effect of the pressure on the resistance of the gutta-percha at that depth would, of course, however, require to be included in the calculation. Your correspondent appears to have unwittingly misunderstood me in this matter, or else he has a weakness for the practice of setting up a figure in order to knock it down by a process of fertile imagination such as one looks for only in fiction.

Charles Bright.

November 28th.

Electrical Engineering Symbols.

Recognising the force of your footnote to my letter printed in the ELECTRICAL REVIEW of yesterday, I herewith send you the Table of Symbols proposed by me some years ago to the Society of Telegraph-Engineers and Electricians with a few improvements and alterations recommended by practical electricians. What faults have you and others to find with them? I notice that Prof. Rücker last week at the Physical Society, London, has been making "*Confusion worse Confounded*" in electrical engineering symbols by using Maxwell's German and other symbols!

FUNDAMENTAL AND DERIVED MECHANICAL UNITS.

L	for length.
M	„ mass.
T	„ time.
V	„ volume.
v	„ velocity.

FUNDAMENTAL AND DERIVED MECHANICAL UNITS.—*Continued.*

A	for	accleration.
J or g	„	„ due to gravity.
F or *f*	„	force.
δ	„	dyne ; *e.g.*, 10 δ = 10 dynes.
W	„	work.
w	„	weight, *e.g.*, w lbs., or w gms.
ft. lb.	„	foot pound.
H.P. or HP	„	horse-power.
I.H.P.	„	indicated horse-power.
B.H.P.	„	brake horse-power.

OTHER COMMON SYMBOLS ALLIED TO MECHANICAL WORK.

D or d	for	diameter.
r	„	radius.
τ_1 τ_2 τ_3 &c.	„	temperatures, absolute.
or t_1° t_2° t_3° &c.	„	„ common.

PRACTICAL ELECTRIC UNITS.

C.G.S.	for	centimetre, gramme, second.
R	„	resistance.
I_R	„	insulation resistance.
ρ	„	specific resistance.
ω	„	1 ohm ; *e.g.*, 10ω = 10 ohms.
Ω	„	1 megohm ; *e.g.*, 10Ω = 10 megohms.
C	„	current.
a	„	1 ampère ; *e.g.*, 10*a* = 10 ampères.
a_t	„	ampère turns.
E	„	electromotive force or E.M.F.
v	„	1 volt ; *e.g.*, 10v = 10 volts.
K	„	capacity.
σ	„	specific inductive capacity.*
mfd or ϕ	„	1 microfarad ; *e.g.*, 10 ϕ = 10 microfarads, or 10 *mfd*, which ?
Q	„	quantity (coulombs).
P	„	power (general term and symbol).
W P or W^p	„	watts or watt-power.
W_J	„	work in joules.
T_h	„	heat in therms or gramme degrees.
J	„	Joule's equivalent.
z	„	electro-chemical equivalent.
R_a, R_s, R_{sh}, R_e	„	resistance of armature, series, shunt, and external circuits respectively.
C_a, C_s, C_{sh}, C_e	„	current in armature, series, shunt and external circuits respectively.
E_a, E_s, E_{sh}, E_e	„	E.M.F. or difference of potential on armature series and external circuits.
L_s	„	coefficient of self-induction.
L_m	„	coefficient of mutual induction.

MAGNETISM AND MAGNETIC UNITS.

N	for	North pointing pole of a magnet, painted red.
S	„	South pointing pole of a magnet, painted blue.
m	„	magnet or strength of pole.
l	„	distance between the poles of a magnet.
M or *ml*	„	moment of a magnet.
H	„	horizontal intensity of terrestrial magnetism.
I	„	intensity of magnetisation.
H	„	magnetic field (in C.G.S. lines).
B	„	magnetic induction (in C.G.S. lines.)
μ	„	magnetic permeability.
κ	„	magnetic susceptibility.*
θ	„	angle of deflection.
r	„	radius (mean) of a coil or solenoid.
n	„	number of anything, *e.g.*, turns of wire in a coil or galvanometer.
R_{as}, R_a, R_f	„	magnetic resistance of *air space*, *armature* core and *field* cores.
K_L	„	Kapp lines.

$$K_L = \frac{a_t}{R_f + R_a + R_{as}}$$ for Kapp's formulæ.

* I should prefer to see κ for specific inductive capacity, and σ for magnetic susceptibility, only the former has been used in so many books.

GENERAL SYMBOLS.

⊣||⊢	for	battery or cells.
ⓓ	„	for dynamo.
T +	„	terminal positive.
T −	„	terminal negative.
E.M.	„	electro-magnet.
F.M.	„	field magnet.
c.p.	„	candle-power of a lamp.
A.M.	„	ampèremeter.
V.M.	„	voltmeter.
S.W.G.	„	standard wire gauge.

We might add more, but the above examples will be sufficient to show that if *all* electricians would agree to use in all these formulæ and communications one common system of letters, it would be a great saving of time and trouble to those who hear and read them.

Andrew Jamieson,
Prof. of Engineering.

The Glasgow and West of Scotland Technical College, *December* 1*st*, 1888.

Can nothing be done to hasten the adoption of common sense symbols, at least in electrical engineering. Some years ago a paper was read before the Telegraph Engineers, which was certainly very suggestive of symbols as they might be agreed upon. At that time a committee was appointed to deal with this subject, but it seems to have gone the way of all flesh. Is there any hope of the subject being settled ? One of our most eminent electricians, a short time ago, spoke of the brain-wasting invention of using inches and minutes instead of the C.G.S. units. This, however, is as nothing when compared with the brain waste in having to plod through the various symbols continually being invented.

There are hardly two of our professors who use the same symbols, and surely we must now be near the finish when we have mastered the terrible array brought up by Prof. Rücker a week ago at the Physical Society. This is enough to make us cry out : "How long, oh Lord, how long !"

W. M. Whirter.

December 3*rd*, 1888.

Electrified Incandescent Lamps.

My attention has been drawn to an article in your valued journal on "Electrified Incandescence Lamps," a subject which I took the trouble to investigate during the years 1880, 1881, 1882, 1883 and 1884. I communicated the facts to Professor Crookes and he also has experienced the phenomenon both in lamps and in the down tubes of the Sprengel pumps. I made numerous experiments, but I am not even now in a position to give a decided opinion upon the results of my many experiments for several reasons, which I should be glad to give to your readers if you think a copy of my experiments would be of general interest. During my experiments I had the opportunity of observing the lamp in all its stages, from the plain tube to the finished lamps, but when I found that the phenomenon of electrification was not confined to a vacuum lamp or Geissler tube, but was also found in the plain down tubes of the Sprengel pumps, then my difficulty to draw a line increased. At one time I thought the phenomenon to be analogous to the influence machine, but I do not think so now. Nor is there any analogy with the frictional electrophorous of any known appliance, or with the dynamo machine. I constructed a single cylinder machine out of a 16 C.P. lamp, but the result was disappointing ; I then to increase ("the spanning") (tension) arranged 12 lamps between two wooden discs ; result, *great quantity* and *constancy* but *no* spanning (no *tension*), nor could I charge the Leyden jar, nor even *insulate* sufficiently from earth or *any* terrestrial object. I then found the best effect was obtained by *simply* exciting (rubbing) *any* lamp and *breathing* upon it ; the phosphorescence light thus obtained I found sufficient to take a negative by. I also proved that the "light" or electrical influence, or fluid,

or phosphorescence "ether," was not only contained *in* the globe, but was *external* as well; a separate experiment proved that. Nor does it matter whether the filament be intact or broken, or whether there is a filament or not. I believe more or less *any vacuum container* may be electrified, and when so the phenomenon of showing phosphorescence light (for that is near, then electric) may be observed. I certainly would advise the construction of cylinder frictional machines with vacuum and mark result.

F. Fahrig.

November 27th, 1888.

Information Wanted.

I take the liberty of communicating with you in the hope that you may be able to give me, or to obtain for me, the solution of the following question :—

"In the decomposition of water, supposing the negative electrode to have a total surface of one square foot, what fraction of a cubic centimetre of hydrogen will accumulate upon its surface before the gas commences to rise, or, in other words, how much hydrogen is required to cover a surface of a square foot immersed in water?"

If you can give me any assistance to enable me to arrive at the quantity it would be greatly esteemed. Apologising for trespassing upon your valuable time and thanking you in anticipation.

H. Rundle.

November 28th, 1888.

[Perhaps some of our readers can assist Mr. Rundle out of his difficulty?—EDS. ELEC. REV.]

The Effect of Placing the Human Body in a Varying Magnetic Field.

We are hearing a great deal just now about mesmerism, &c., &c. I will not enumerate all the isms, quack and otherwise. But as I am not aware of what may have been done in regard to the above subject, I think that a lot may be ascertained by experiments in that direction. There are many reasons for believing that the brain is but a high potential battery, its composition and cellular construction, and, remarkable above all, its serial arrangement, with alternate *different* fluids and diaphragms. Is it probable that we have in our heads, in a mechanical sense, but a set of double fluid cells arranged in various ways? I am aware of the scepticism of the human mind (by the way, I am not saying anything as to what constitutes mind), and how, in regard to such a subject as this, particularly, any mere theorist is likely to be tremendously sat upon. As long, however, as the criticism is fair and to the point, so far so good. To go on—from the brain we have stout conductors running down and branching off in all directions into smaller and smaller circuits, until we arrive at the most extraordinary ramifications, almost inconceivable.

If the blood channels are so very, very fine, what must be the fineness of the nerves supplying the more distant parts from the mains?

I have read somewhere that in France magnetism has actually, directly or indirectly, transferred the disease of one person to another previously unaffected. This may or may not be correct; but true it is, that the body carries good conductors below the epidermis, as battery workers well know when that, by corrosion or otherwise, has been removed. Assuming then that the bulk of the conductors run parallel to the limbs, and that the feeling, as we call it, of the extremities may be easily stopped by severing the conductors, is it not reasonable to suppose that when these currents traversing the system are subjected to the influence of a suitable magnetic field, that the ordinary effects of induction must operate?

Is it not very reasonable that if we are walking batteries and mazes of wires that we should be able to influence each other without actual contact?

Certain forms of giddiness are probably due to a disorganised battery; pain may be the result of short circuits, as exhibited in inflammation and other ways.

Of course we can hardly expect anyone to allow themselves to be rotated in a magnetic field, or even to be subjected to sudden movements to cut magnetic lines, but we can conveniently dispense with that very giddy operation by moving the magnets instead to ascertain the effect. The effect of volatile compounds, such as alcohol, is very significant when we consider the brain to be a delicately-constituted battery, and especially with ether and chloroform are we approaching some genuine knowledge. It is found that when a patient subjected to these anæsthetics is placed upside down, on his head that is, the ether hardly acts, for the simple reason that it cannot be made to stop next the brain through its lightness, comparatively with air, and even when applied in the usual way if the patient be afterwards placed as described sensibility soon appears. What does all this mean? There are many explanations of the effect the alcohol would have, chemically alone, upon the brain matter, but I will leave this for another letter after I see how you entertain this one.

James C. Richardson.

November 30th, 1888.

Sir David Salomons's Resistance Governor.

I observe that you have done me the honour to describe a piece of apparatus devised by me and which has proved very successful in practice. I think it fair to state that the notion is that devised by Messrs. Porte and Manville. This patent is held by Messrs. Woodhouse & Rawson, and I found it a convenient notion so applied it, being cheaper than making up a new one for the purpose. The name of the apparatus should really be "Counter E.M.F. Governor" as it is best to employ this method of regulation on the lines, but for the regulation of current or E.M.F. given by the dynamo, resistances appear to answer best. The governor can be used equally for direct and alternating currents, but in the latter case neither cells nor resistances are used, but impedence coils in their simplest form, and the regulator is a special one. These governors have been greatly improved since the blocks, from which your plates are taken, were engraved.

After these remarks I trust the notion that I have purloined Messrs. Porte and Manville's invention will be corrected, for your article reads this way without your having intended it to do so.

David Salomons.

December 1st, 1888.

Referring to the above instrument in your issue of the 30th ult., I may say that the idea of this resistance governor is by no means new, as numerous experiments were tried with an instrument similar to that described in the early part of this year, and was working successfully at Messrs. Harland and Wolff's lighting station in their works here about the month of June.

The ratchets were driven from the main shaft by a small eccentric, and an electro-magnet was connected in series with the external circuit, which, when the E.M.F. got too high by a lamp in the circuit going out, or from any other cause, the magnet was attracted, and by a simple arrangement switched the current from a few Leclanchè cells through one ratchet coil, thereby attracting the ratchet on to the ratchet wheel and placing the required resistance in the circuit; likewise, when the E.M.F. got too low the magnet fell, and by making connection with a second contact, switched the current on to the other ratchet coil, thereby attracting the ratchet and acting in a similar manner as before, but switching out the resistance until it reached the proper E..M.F. The ratchet wheel was connected directly to the lever of the resistance switch, and the pitch of the wheel was equal to the distance between the resistance contact pieces.

When the resistance lever reached either extremity, and by pressing against similar contacts to that in fig. 1 of the issue referred to, an electric bell was made to ring so as to inform the attendant that the resistance was either all in or all out of the circuit, the bells for each being of a different tone, so as to indicate the

former or the latter conditions. This, I think, is a splendid addition to the instrument over that designed by Sir David Salomons (?).

Chas. Esson.

Belfast, *December 3rd*, 1888.

Proposed New Cable.

It may interest you to know that, according to a Panama journal, a contract has been signed between the Minister of Public works at Nicaragua and Senor Creus, by which the latter gentleman receives permisssion to land a cable on the Atlantic coast of Nicaragua. The journal states that the cable will connect the Nicaraguan Republic with the West Indies and New York, and that the Government guarantee that the traffic over the line shall not give less than $6,000 per annum. Work on the cable has to be commenced within the next three years.

For W. T. Henley's Telegraph Works Co., Limited,
G SUTTON, *Manager & Secretary.*

December 1st, 1888.

Quack Medical Batteries.

I enclose advertisement found between the pages of an ELECTRICAL REVIEW bought from McCrae, Curtice & Co., Catherine Street, Strand, on Saturday last. This is a glaring example of the policy so often condemned in your columns. It is a pity your high class journal should be made the medium for circulating such rubbish.

C. H. Yeaman.

December 1st, 1888.

[As previously stated, these insets are inserted after the REVIEW has left this office.—EDS. ELEC. REV.]

"Industries'" Reviewer.

That your contemporary *Industries* should have been made the victim of a practical joke by some stupid reviewer is a matter of very great surprise to many of its readers. I have been informed by authors that it is usual to review a book from the standpoint of the date at which it was written, but the reviewer in *Industries* takes up my little pamphlet about two years after it was written, and with his two years' additional knowledge proceeds to demolish me in great style.

He says that manufacturers will find nothing in my book to guide them in selecting the best form of apparatus. I should like very much to have particulars of any transformers containing any detail which differs essentially from the transformers described in my book. I venture to assert that the book describes the best transformers in every detail, and that the transformers since then introduced are all built upon the principles and lines laid down therein. Every manufacturer thinks his own transformer the best form, and selects a form of iron stamping for the core of his transformer which does not in his opinion resemble the form of sheet iron stamping used by his rivals.

At the date of the writing of the book, not one electrical engineer in a hundred even knew that if the windings of an induction coil were as 10 is to 1, that the terminal pressures would be as 10 is to 1 also. In fact, only a few who had been making a special study of them knew anything whatever about them, and as none of the few seemed to care about publishing any of their knowledge, I took the trouble to write up a few notes which subsequently were made into the small book. I received most gratifying letters from most unexpected quarters, and from all parts of the world, thanking me for the work immediately it was published.

A great many papers and publications followed upon the publication of the work, and thereby knowledge on the subject was vastly added to. Patents for transformers and alternating current apparatus became very numerous, and if the publication of my notes had anything to do with this increase of attention to the subject and with the publication of knowledge possessed by others, one of the chief ends of the book has been achieved.

The work was translated into German by Dr. Martin Kreig, of Magdeburg, with considerable additions, and is now going into a second edition. Altogether the book has been a success in every way, and the last copy was sold months before the practical joker in *Industries* commenced his "review." There is something to recommend this idea of reviewing a book after it is sold out; the author can afford to laugh at the reviewers of *Industries*' kind.

Rankin Kennedy.

Glasgow, *December 4th*, 1888.

A Retrospect.

The voting papers of the Society of Telegraph Engineers and Electricians are now in the hands of members, and to telegraph men cannot but afford matter for painful reflection. Here is a society initiated, maintained and made a success chiefly by telegraph engineers, and yet things have come to such a pass that neither in the council itself nor in the list of members recommended by the council for election is there a single representative of purely telegraph work. Among the past presidents alone can any such be found, and these it is out of the power of our precious council to supersede. As no new members are being added to the list the time is not far distant, when, if we do not take the matter into serious consideration telegraphy will be entirely ignored. The very name of the society is about to undergo "rectification" so as to extinguish the last faint glimmer of what was once a powerful factor in the scientific world.

Ten years ago this society had on its council such names as Scudamore, Latimer Clark, Preece, Walker, Webber, Willoughby Smith, Bright, Forde, Varley, Andrews, &c. To-day, except among the shelved presidents, there is not a single name known to telegraphy. One by one they have been weeded out, evidently in pursuance of a fixed policy, until recently the last connecting link between the old society and the collection of professors now in power, was ousted so rudely that he withdrew from the society altogether. I refer to Mr. W. T. Ansell, whose action in this instance many of his friends deplore. He ought to have stuck to his guns for the sake of the principle involved. The telegraph interest is surely strong enough and important enough to insist upon due representation in its own society, and we ought not to permit our share in the society to pass out of our hands, if only for the sake of our inheritance in the Ronalds Library, which was left to the Telegraph Engineers. The society was made by telegraphy, and it is not creditable that in an electrical institution room cannot be found for advance of the science which has done more to benefit humanity and promote the progress of the world than any other agency in the present century.

The Government, railway, and private telegraph companies, and the Submarine Cables ought to have representatives on the Council, and I would suggest that as time will not admit of previous discussion and arrangement, some such list as the following should be adopted by all telegraph men, whose voting papers should be amended as follows:—

Members.—James Radcliffe, Esq., Great Northen Railway, Retford; Sir James Anderson.

Associates.—C. H. B. Patey, Esq., General Post Office; W. J. Tyler, 106, Cannon Street, E.C.

It is possible that some of these gentlemen may not agree to serve, but no harm will be done, and the chief point is to assert the right of telegraph-engineers to be represented. This end can only be attained by adopting such a list as that given above, and I trust that all telegraph members and associates who have the interests of the society at heart and are proud of their profession, will include these gentlemen in their voting list.

Telegraphy.